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HANFORD LABORATORIES OPERATION MONTHLY ACTIVITIES REPORT

MAY, 1959

JUNE 15, 1959

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AVAILABLE

HANFORD ATOMIC PRODUCTS OPERATION

RICHLAND, WASHINGTON

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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
MAY, 1959

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By Authority of CG-PR-2
DS Lewis 6-29-92
By J Tang 7-1-92
PM Eck 7-2-92

Compiled by
Operation Managers

June 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRELIMINARY REPORT

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

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TABLE L. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE June 9, 1959

	At close of month			At beginning of month			Additions		Separations	
	Exempt	NonExempt	Total	Exempt	NonExempt	Total	Exempt	NonExempt	Exempt	NonExempt
Chemical Research and Development	126	95	221	126	94	220	1	3	1	2
Reactor & Fuels Research & Development	191	138	329	187	135	322	6	5	2	2
Physics & Instrument Research & Development	65	33	98	66	32	98	0	1	1	0
Biology Operation	35	42	77	35	44	79	0	0	0	2
Operation Res. & Syn.	15	2	17	15	3	18	0	0	0	1
Radiation Protection	33	101	134	33	100	133	0	1	0	0
Laboratory Auxiliaries	47	189	236	47	185	232	1	9	1	5
Financial	14	26	40	15	27	42	0	0	1	1
Employee Relations	39	22	61	40	23	63	3	1	4	2
Programming	14	4	18	14	4	18	0	0	0	0
General	1	2	3	1	2	3	0	0	0	0
Totals	580	654	1234	579	649	1228	11	20	10	15
Totals excluding Internal Transfers	580	654	1234	579	649	1228	11	18	10	13

Composite Separation Rate 2.0259

Separation Rate (based on separations leaving G. E.) 1.0534

Controllable Separations Rate .2431

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BUDGETS AND COSTS

Costs for May were $1,843,000, an increase of $11,000 from the month of April. Fiscal year-to-date costs are $17,845,000 or 85% of the operating budget of $20,959,000. Hanford Laboratories operating budget for FY 1959 increased $449,000 during May due to:

Increase in Plutonium Recycle Program resulting from a transfer of $200,000 from equipment and receipt of an additional $200,000 from AEC	$400,000
Increase in Swelling Studies provided by a transfer of $25,000 from IPD's Maritime Gas Loop	25,000
Increase in CPD sponsored Weapons R and D Program	14,000
Decrease in CPD sponsored Separations Development	(45,000)
Increase in two U. S. Air Force sponsored programs	
Plutonium Inhalation Studies	24,700
Atmospheric Diffusion Studies	30,000

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

PRTR construction phase completions versus schedules are: Phase I, 98.5% versus 99.4%; Phase II, 99% versus 100%; Phase II-A, 84% versus 100%.

PRTR loss-of-coolant incidents analyses by Battelle are essentially complete.

Eighty-three Zircaloy-2 PRTR process tubes have been inspected and accepted at the vendor's plant, and approximately 14 more potentially good tubes are nearing completion. The first fifty of these tubes are already at Hanford.

The first BMI temperature-cycling creep test (out-of-reactor) on 15 percent cold worked Zircaloy-2 is reassuring in that the overall creep was not significantly increased by reoccurrence of primary creep with each temperature cycle.

Laboratory tests show the hydriding of Zircaloy-2 by molecular hydrogen is dependent on both the temperature and the amount of water vapor

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or oxygen in the hydrogen. At 400 C, 0.1 mm of Hg water vapor pressure is sufficient to completely inhibit the hydriding reaction in short-term tests.

Thermal expansion coefficients of reactor graphites may assist in selecting graphite types which are more dimensionally stable when irradiated at high temperature (500 C and above). At least three promising NPR graphites are undergoing irradiation testing.

Three 7-rod cluster fuel elements were discharged from the ETR 3x3 loop after operating in 280 C coolant to an exposure of 900 MWD/T. Power generation ranged from 70 to 114 kw/ft.

Six prototype NPR 7-rod cluster elements were built during the month in three lengths: one, two, and three feet. Assembly was accomplished within the dimensional tolerance of 0.010-inch on the outside diameter and within the rod to rod spacing tolerance of 0.003-inch, employing prototypical end spiders and intermediate spacing devices.

Eight tube-tube Zircaloy coextrusion clad elements were constructed of NMI stock for irradiation in the KER loops. The first tube-tube element was charged into KER-1 in May. The element containing U-2% Zircaloy fuel will be discharged for examination after 250 MWD/T exposure. An additional tube-tube element has been shipped to the ETR for irradiation in the 6x9 facility at about 360 kw/ft. Goal exposure is 2000 MWD/T, and the calculated temperature is 700 C.

Equipment for simultaneously hot bonding both ends of fuel rods 12 inches long preparatory to end closure has been developed. It will be employed in producing 7-rod cluster elements for KER testing.

Preparation of approximately 1200 pounds of arc fused UO_2 was completed by the Norton Company as part of the PRP fuel development program.

Radiation damage effects in UO_2 are being studied by metallographic examination of polished and etched surfaces and by fractography. Small voids which have been detected at grain boundaries in UO_2 irradiated to 0.015 a/o burnup are presumed to arise from migration of gases trapped during the fabrication processes, generation and migration of fission gases, or a combination of both mechanisms. Examination of material irradiated to 0.022 a/o burnup is expected to reveal trends in the radiation behavior of UO_2.

Post-irradiation examination of Pu-enriched, UO_2 fuel clusters has revealed relatively little of the cracking and fragmentation observed in irradiated UO_2.

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A mixture of plutonium carbides has been made by heating plutonium metal and carbon in vacuo at 1050 C. PuC and Pu_2C_3 have been identified.

Experimental roll compacting of metal clad ceramic materials has been initiated. Forty percent reduction has resulted in 75% of theoretical ceramic density.

Defected elements of Zircaloy-clad 2S aluminum showed only slight swelling after 30 hours in 300 C pH 9 water.

2. Chemical Research and Development

Laboratory results continued to provide support for Purex plant extraction of neptunium by simpler and less expensive process methods. In addition, the use of dibutyl butyl phosphonate (DBBP) looks encouraging as a specific extractant for recovery of neptunium from Purex aqueous waste (1WW).

Continuing work on the recovery of specific fission products included study of optimum cerium and promethium sulfate precipitation from a synthetic Purex waste source (1WW). Preliminary experiments for separation of rare earths by ion exchange techniques were initiated. In addition to precipitation processes, tall oil (a high molecular weight fatty acid) and di-2-ethyl hexyl phosphoric acid show promise of being useful for the extraction of cerium and strontium from neutralized Purex 1WW waste.

Very effective separation of deuterium from hydrogen-deuterium mixtures was demonstrated by a hydrogen displacement technique in a column of "Raney" palladium dispersed on asbestos. A separation factor of 45 was calculated with data from the experiment.

Excessive fines were produced when simulated UO_2 reactor fuel rods were cut up in a hydraulic shear under water with considerable suspension of the fines occurring throughout the water system. On the other hand, simulated NaK bonded fuel was cut (by sawing) under inert gas blanketed water with satisfactory results. NaK reaction with the water is rapid, but not hazardous.

Pilot Plant studies of the Niflex (HNO_3 - HF) dissolution process in the Hastelloy F dissolver were completed and the unit is being converted to study Sulfex (H_2SO_4) dissolution on a large scale. Corrosion of Hastelloy F equipment by HNO_3 - HF mixtures remains a problem which may negate the use of this reagent except for special purposes. A heat transfer surface of Hastelloy F exhibited excessive corrosion in Darex (HNO_3 - HCl) media at the liquid-gas interface.

The use of high concentrations of ferric ion in nitric acid dissolver solutions to yield stable feed solutions of U-Mo reactor fuels continues to look good. Scouting studies of the behavior of these feeds in the Redox

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process were generally favorable.

Cycling UO_2 into solution in fused NaCl·KCl by phosgene or chlorine oxidation with subsequent reduction to a UO_2 precipitate continues to be an attractive pyrochemical method for ceramic fuels processing. The study was extended during the month to include the behavior of irradiated UO_2 specimens, in particular, the route of fission products during the cycle.

Experiments with the radiant heat spray calciner showed neutralized 1WW Purex waste to be a problem because sodium nitrate in the waste formed a coating on the radiating walls and required shutdown of the unit. The addition of sugar to the waste alleviated the problem by reacting with the nitrate present and producing well behaved product powder which is predominantly sodium carbonate.

The first experiment with 47 foot long soil columns showed behavior generally predictable from extrapolation of previous results of shorter columns. The radiostrontium used eluted in a fashion to show that the adsorption-desorption front in the column becomes better defined with increasing column length.

3. Physics and Instrument Research and Development

In the improved production reactor program, a series of exponential pile measurements using solid natural uranium rods 2.5 inches in diameter, has been completed. Work is in progress on solid 1.92-inch rods and concentric tube fuel elements.

In the nuclear safety field, experiments continued to obtain critical masses under various conditions for 3% enriched NPF fuels. Consultation on problems in this field continued at a numerically high level.

Measurements were completed on the lattice for the Allis Chalmers-Kaiser Engineers gas-cooled reactor. Preliminary numerical values were obtained for the lattice parameters. Meanwhile, theoretical and experimental work was in progress to determine the effectiveness of a proposed control rod in this same lattice.

Two experimental nuclear-incident alarms successfully passed tests at Los Alamos where facilities are available for simulating such incidents. Meanwhile a recently completed study indicated that early warning of a potential criticality incident may be obtainable in some cases.

Orderly progress was made on the many projects in the instrument field. Of special interest was the opening of a lead which may substantially improve the sensitivity of film badge readings. Also, an improved model of the Vernier Chronotron was successfully tested.

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The mass spectrometer constructed for a Washington Designated Program was used on a plutonium sample for the first time this month. The results agreed with analyses done at ORNL on the same sample.

In the basic data field, arrangements were completed to extend our international comparison programs on graphite cross sections to include West Germany.

4. Biology

Bean plants grown in nutrient solutions containing widely differing ratios of strontium and calcium contained essentially the same ratio of these two ions in the whole plant as in the nutrient solution.

A second ewe fed 1.5 μc of I^{131} daily for the past four and one-half years (after being born to and weaned from a dam on the same radioiodine regimen) showed a thyroid tumor at autopsy.

5. Programming

A study of power producing radioactive isotopes showed that U-232 and its daughter Th-228 have significant potential. These isotopes could be produced by the irradiation of Th-230 which is available from natural uranium.

The Monte Carlo and associated portions of the RBU computer code are now in usable condition. A sample problem directly applicable to the Plutonium Recycle Program has been run.

Reactor effluent water problems were reviewed and recommendations made concerning a new course of action with respect to the direct disposal of effluent streams to the river.

TECHNICAL AND OTHER SERVICES

The development work required to utilize generalized classical linear methods of estimation in connection with the investigation of causal interrelationships has been completed. Emphasis will now be placed on the utilization of these techniques to formulate plant models.

A complete progress report on the Z Plant Information Study was presented to interested managers and a proposed test program agreed upon.

Irradiation Processing Department has requested that work on systems reliability previously initiated by CE & UO be continued and extended.

Data from the recent PRTR containment vessel test are being evaluated in

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order to determine the precision of leakage rate estimates and obtain a basis for improved procedures in future tests.

Work on 2 operations research studies and 8 operations analysis programs continued during the month. Two new operations analysis programs were defined, one an offshoot of the development work connected with the input-output simulation study and the other a result of previous statistical work. In addition, statistical and mathematical analysis on 19 problems was given within HLO and to other departments and operations.

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

There were 21 authorized projects at month's end with total authorized funds of $8,423,000. The total estimated cost of these projects is $8,606,500. No projects were completed during the month. Two new projects are awaiting AEC approval. Six project proposals are in preparation and four were completed and are in process of being submitted to AEC.

Total productive time for the month in Technical Shops was 17,102 hours. This includes 13,358 hours performed in the Technical Shops, 852 hours assigned to Minor Construction, 122 hours to other project shops, and 2,770 hours to off-site vendors. The total shop work backlog is 22,112 hours of which 50% is required in the current month, with the remainder distributed over a three month period.

During the month Radiographic Testing Operation moved to laboratory facilities in White Bluffs. PRTR facilities at this location for pickling and autoclaving zirconium process tubes are nearing completion. Productive work during the month was low due to the move. Tests totaled 2,926.

The Contract for construction of the Critical Mass Laboratory was awarded to the low bidder, Howard S. Wright Construction Company, at a price of $442,025. The fair cost estimate for the work was $408,000.

Construction of the 306 Building Addition is proceeding on schedule. Design work is behind schedule due to the addition of design work for the Chemical Processing Area. The construction contractors schedule will be extended when the chemical processing area construction work is negotiated, but this is not expected to extend the total job schedule.

In-reactor equipment for the 6x9 test hole in the ETR at Idaho Falls was completed. A non-fuel bearing experiment is now being operated; testing at operating temperature with fuel elements is expected to be accomplished in June.

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SUPPORTING FUNCTIONS

Reconciliation work in connection with the physical inventory of uninstalled cataloged equipment in the custody of Chemical Research and Development is complete. Significant statistics are: counted were 2,468 items valued at $1,751,803; missing were 10 items valued at $2,973.

A final draft of the travel manual has been reviewed and should be ready for issuance shortly. It should provide assistance to those traveling in obtaining authorization, funds and accounting for their travel.

Personnel Accounting clerical functions were transferred to Contract and Accounting Operation effective April 27. Two people remain in the HLO Financial Operation to handle the necessary field business.

Funds from special budgets for attendance at off-site courses and professional societies for FY 1959 are almost totally committed at the end of May.

At month's end, the staff of the Hanford Laboratories totalled 1234 employees, including 580 exempt and 654 nonexempt employees. There were 497 exempt employees possessing technical degrees, including 286 B.S., 110 M.S. and 101 Ph.D.

Tours were provided during May for 95 high school students, 80 college science and engineering students and 25 presidents and faculty members of Washington junior colleges.

Radiation Protection Operation provided display material and guides to Armed Forces Day Open Houses at Larson Air Force Base and Umatilla Ordnance Depot.

At the May meeting of the HLO Suggestion Board four awards totalling $120 were granted. Awards for Hanford Laboratories for the calendar year total $935.

A Laboratories employee on educational leave, Jack L. Poe, was awarded a General Electric scholarship for the 1959-60 school year.

Laboratories personnel worked a total of 188,800 man-hours during the month with no disabling injuries. Since September 1, 1956 a total of 6,275,127 man-hours have been completed with no disabling injuries.

The medical treatment frequency for May was 1.58 compared with 1.49 last month.

There were no security violations in the Laboratories in the month of May. The total for the year remains at 16.

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One Ph. D. candidate, a physiologist, accepted an HLO offer during the month. For the current year to date, there have been ten Ph. D. acceptances for HAPO.

Thirteen experienced BS/MS acceptances were received during the month. Seventy-one acceptances for Technical Graduate assignments have been received and these new employees will be signed on the payroll during June and July.

Three Technical Graduates were added to the Training Program and one permanent placement was effected with 28 remaining on the Program at month's end. The first summer employee, a college junior, was added to the payroll during the month.

Nineteen requisitions were filled during the month. With receipt of 17 new requisitions, there are currently 44 nonexempt openings, for which 28 candidates are in process and 4 transfers pending, with 12 candidates yet to be procured.

HM Parker

Manager,
HANFORD LABORATORIES

HM Parker:bms

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Corrosion Symposium. The 8th Annual AEC Corrosion Symposium was held at HAPO on May 12 through May 15. Forty papers on various corrosion subjects were presented by authors from 14 different sites. The program also included an evening panel discussion on the "Major Corrosion Problems in Reactor Development." The meeting was attended by 63 people from 29 other sites, as well as by HAPO personnel.

Fuel Element Rupture Kinetics. Rupture rate curves have been measured for defected fuel element samples autoclaved in 200, 250 and 300 C water and 475 C steam. The samples were coextruded Zircaloy-2 clad uranium cores with an assembled diameter of 0.6 inch. They were beta-treated at 730 C for 10 minutes followed by 10 minutes at 600 C and then air cooled. They were defected with a 25-mil hole drilled through the cladding into the core. Rate curves were determined by measuring the rate of hydrogen generation. The results to date can be described by an induction time followed by an initial rate which is maintained during corrosion of the first 20 to 30 grams of core material. This is followed by a higher rate for the next 30 to 40 grams of core corroded. Typical data are as follows:

Temp.	Pressure	Induction Time	Initial Rate, Grams U/min.	Final Rate, Grams U/min.
200 C	500 psig	17.5 hrs.	0.12	0.4
250 C	1500 "	100 min.	0.38	1.20
300 C	1500 "	50 "	0.18	1.14
475 C	1500 "	36 "	0.20	1.38

The data at 300 C are based on five determinations and the other data are based on one run at each temperature. Duplicate samples will be run at these temperatures. The induction times decrease markedly with increasing temperature. The rupture rates inferred from H_2 release rates are relatively insensitive to temperature, those at 250, 300, and 475 C being essentially the same within the experimental limits. The 200 C run will be repeated at 1500 psig pressure; however, preliminary indications are that the pressure is not an important parameter.

A sample of U - 2% Zr core material coextrusion-clad with Zircaloy was predefected and autoclaved at 300 C, as above. The rupture rates were significantly lower than for the unalloyed uranium cores. The induction time was seven hours, and the final rate was 0.012 gram U/minute which persisted for another seven hours, and the final rate was about 0.1 gram U/minute.

A sample of uranium core, Zircaloy-2 clad, material was hydrided to produce a calculated 5000 ppm H_2 concentration in the cladding. The sample, which was not predefected, was autoclaved. After an induction time of 47 minutes, the sample failed by splitting off the unbonded end-cap, following which the rate of attack on the core was 0.6 gram of U/minute.

Radiometallurgy Laboratory Studies

A total of 23 density determinations that were accurate to 0.1 to 0.2% were made on irradiated uranium samples from stainless steel-clad and Zr-2 clad, 7-rod cluster fuel elements. Faxfilm replicas were obtained from the inner component of an irradiated coaxial fuel element and from a fractured surface of a uranium sample that was annealed at 600 C for 24 hours. More specific results and conclusions from this work will be reported in connection with the respective development programs of Fuel Design and Physical Metallurgy Operations.

Basic Metallurgy Studies

Radiation Effects in Fissionable Materials. A series of flat uranium tensile specimens have been irradiated for short exposures and at low temperatures in the snout facility at 105-KW. The purpose of this test is to find the threshold of detectable neutron damage to uranium. The exposures range from 10^{15} to 10^{18} nvt or from 5×10^{-7} to 5×10^{-4} total a/o burnup. Hardness and yield strength were found to be markedly affected by even the lowest irradiation. Correlation of property changes with exposure has shown that damage occurs at two distinct rates in the early stages. Initially, there is a rapid increase in properties. After an accumulated irradiation just sufficient to have thermally spiked the entire volume of the uranium, a second, lower rate of damage accumulation is observed. The nature of the damage accumulation and annealing effects indicate that an extended defect is being produced during the second stage of damage accumulation. The extended defect concept is given credence by x-ray diffraction evidence of a faulting mechanism in materials irradiated in the same manner. A topical report, HW-60326, describing these results has been completed.

A turbo-mechanism has been developed that will rotate an irradiation capsule so that the enclosed specimens will receive a radially uniform exposure to the neutron flux. Comparative irradiation tests using both rotating and stationary capsules are being performed. One rotating and one stationary capsule containing natural uranium were charged in the MTR during the month. Similar capsules containing enriched uranium were charged previously and have reached 25 percent of their goal exposure.

Testing of irradiated thorium, an isotopic cubic metal, should yield data that can be interpreted more simply than that from dimensionally unstable uranium, although the fission effects in both metals should be comparable. Fifteen capsules containing thorium specimens which received a total integrated thermal flux of 3.2×10^{20} nvt for a

0.045 a/o burnup of U-233 were discharged in March. Fifteen capsules irradiated to a 0.1 a/o burnup of U-233 were discharged this month. Fifteen capsules which are to receive 0.07 a/o burnup of U-233 are to be discharged in November. All discharged capsules have been isolated for basin storage until Radiometallurgy scheduling permits examination.

Radiation Effects in Structural Materials. Information is currently needed concerning property changes in high strength materials which may occur under combined high temperature and high flux environments. Room temperature tensile properties have been determined for Zircaloy-2 after irradiation to an estimated integrated fast neutron flux of 4×10^{20} nvt at 280 C. The yield strength was raised 40%; the ultimate strength was not changed; the total elongation was reduced 32%; and the uniform elongation was decreased by 51%. In the plastic range the tensile data were analyzed from the standpoint of true stress and true strain as these properties are more meaningful for large strain where the sample area is decreasing. The analysis was limited to the range of uniform elongation where a region of low work hardening was found to be present after irradiation. This was manifested by a reduction of the hardening exponent from 0.2 to 0.1. Comparison of these results with room temperature tensile data for Zircaloy-2 irradiated at 50 C to an estimated thermal flux of 1.2×10^{21} nvt indicates that the yield strength and ultimate strength are not increased as much by the high temperature irradiation; however, the strain hardening exponent and the uniform elongation show decreases similar to those caused by low temperature irradiation. This latter fact is important in considering the application of Zircaloy-2 at elevated temperatures since it indicates that ductility will decrease.

A series of metals representing the common crystal types was irradiated at Brookhaven, Hanford, and the MTR under various exposure conditions. These metals include copper, nickel, titanium, zirconium, iron, molybdenum, and type 347 stainless steel. Metallographic studies of irradiated zirconium, titanium, and molybdenum were started during the month. X-ray line broadening studies prior to annealing were started for unirradiated copper and nickel, and completed for unirradiated zirconium and titanium. Qualitative analysis by emission spectroscopy of the chemical impurities in the unirradiated materials is about 50 percent completed.

A Zircaloy-2 tube which has been exposed to radiation over a 25-month period, and a similar unirradiated tube were removed from the KER facility. These tubes will be mechanically tested and examined metallographically to determine the effects of high neutron exposures at elevated temperatures on Zircaloy-2 and to establish testing methods for monitoring NPR tubing. The sectioning of the tubes into test pieces was started during the month, and a program document describing the tests to be performed was written.

Sheet tensile specimens of several candidate reactor structural materials have been irradiated in the 105-KE magazine facility for periods of one, six, and twelve months. These materials include Zircaloy-2, Zircaloy-3, the aluminum alloys X-8001 (M-388) and M-257, the magnesium alloys

HK-31A-H24 and A-3XA-O, and AM-350 stainless steel. These materials will be tested to determine the effects of neutron radiation on mechanical properties. The specimens exposed for twelve months were discharged and transferred to the Laboratories during the month.

The effects of reactor irradiation on the microstructure and properties of zirconium alloys are being evaluated by studies of high resolution metallography, x-ray diffraction, hardness, optical microscopy, and damage annealing kinetics. A capsule containing one specimen each of annealed, 10% CW, 25% CW, 50% CW, and a beta quenched specimen was discharged from KER Loop 3 in March after receiving an approximate exposure of 9×10^{19} nvt at 220 C. The capsule was transferred to Radiometallurgy during the month where the activity measured through two feet of water was found to be 200 mr. A power hacksaw is being installed in one of the hot cells for opening this capsule.

Mechanical and Physical Properties of Materials. Measurement of creep of Zircaloy-2 is in progress with all five of the vacuum creep machines in operation. Specimens of 25 and 45 percent cold worked materials are being tested with combinations of stresses from 13,200 to 21,100 psi at 400 C (752 F). The 45 percent cold worked specimens are exhibiting a higher creep rate, after a lower initial deformation, than the 25 percent cold worked material. This higher creep rate appears to be the result of recovery of the cold worked specimens. Zircaloy-2 specimens from this same lot are being tested in the annealed condition and in the 15 percent cold worked condition at Battelle. They observe some recovery at the same temperature on the 15 percent cold worked material. Creep machines for the testing of specimens in an atmosphere of helium and carbon dioxide are now being placed in operation.

The textures of extruded and drawn Zircaloy-2 tubing are being determined by x-ray diffraction. The preferred orientations are being correlated with results of tube burst tests in order to explain differences in longitudinal and hoop strengths of jacketing materials. Extruded Zircaloy-2 (39:1 extrusion ratio) shows a highly preferred orientation of basal planes (0002) which are oriented parallel to the extrusion axis and the tube radius. This orientation would account for high values of hoop strengths found by tube burst testing. The structure of Zircaloy-2 tubing annealed at 700 C for one hour introduced some difficulty in analysis, since it was coarse grained. A less pronounced texture of the same type was found in the annealed material.

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. Thin films prepared by vacuum evaporation or by electron chemical thinning of rolled sheet can be irradiated and then examined directly in the electron microscope for structural changes. Analysis of microstructural and electron diffraction changes in irradiated aluminum and uranium dioxide films is continuing. The originally uniform uranium dioxide film, 13 Å thick, shows straight line tracks of low electron scattering power after an irradiation to only 2×10^{16} nvt. With increasing exposures up to 3×10^{17} nvt, the number of tracks increases. With higher exposures the film becomes so heterogeneous that the tracks

are no longer apparent. The tracks are all approximately 150 Å in width and vary in length from 150 Å to 30,000 Å. Calculations on the validity of interpreting each track as being the path of the fission fragment penetrating the 13 Å thick film are in progress. Changes in the lattice parameter associated with the low irradiation exposures is consistent with previous observations, namely, a contraction of the UO_2 lattice occurs. Thin sheets of uranium and Zircaloy-2 are being fabricated as starting stock for the preparation of thin foils for subsequent irradiation studies.

X-Ray Diffraction Studies. The preselecting camera is being used to assist in identifying various compounds in the AlSi bond layer of production fuel elements. A fuel element has been sectioned and polished tangentially to provide a larger study area for each compound. This technique assists in eliminating interfering diffraction lines.

At the request of Coolant Systems Development Operation, the crystal form of magnetite was determined following exposure for up to five weeks in pH 4.50 (H_3PO_4) high purity water at 300 C and 1400 psi. Although the material became progressively more discolored with exposure time, the crystalline form of the body centered cubic Fe_3O_4 did not change.

Solid State Reactions. The kinetics of recrystallization and recovery in zirconium, Zircaloy-2, and Zircaloy-3 are being determined to establish the optimum conditions of heat treatment during fabrication operations. Zirconium electrical resistivity data have been evaluated during the month. It was noted that annealing of ten percent cold work specimens in vacuum, helium, and air for 1000 minutes at 300 C resulted in varying amounts of recovery. The largest recovery of resistivity occurred in air, followed by vacuum and then helium. The same trend is evident after 400 and 500 C anneals. This would tend to indicate that gas contamination has occurred. The fact that more recovery was seen in the air anneal than in the helium anneal supports the work of Gulbransen and Andrew that a thin oxide film offers a resistance to hydrogen permeation; also, that the gas in question is probably hydrogen, and that some contamination occurred in a dynamic vacuum of 1×10^{-4} mm of Hg. A comparison of recovery of electrical resistance of specimens annealed in vacuum and helium indicates a contaminant in the helium which probably was not oxygen. Oxygen contamination would be expected to show the effect of an oxide protective film similar to that observed after an air anneal. An air anneal of 25 percent cold work material under the same conditions listed above shows that 25 percent cold work material is more susceptible to contamination than either 10 percent or 50 percent cold work material.

In-Reactor Measurements. A creep capsule has been received from Technical Industries Corporation that was built for the purpose of providing continuous creep measurement of a Zircaloy-2 specimen while being irradiated. The production test authorizing the charging of the capsule has been prepared. The creep capsule is complete with leads, monitoring equipment, heaters, and pressure control equipment to give continuous indications of load, temperature, and strain. The operating temperature can be controlled and maintained up to 400 C, even during reactor shutdown periods. It contains a bellows system for loading the sample to a

maximum stress of 40,000 psi, and a strain transducer to measure the elongation of the specimen to a total of 0.4 inch with a 2.5×10^{-4} inch least scale sensitivity. An extension-transducer monitor system similar to the one in the capsule is being tested in the laboratory to determine its accuracy and stability. No change in sensitivity or calibration as a function of temperature has been found; however, zero drift occurs. Tests are being made to determine whether this drift is temperature or time dependent.

In-reactor testing of thermocouple insulation has been completed. Asbestos and a low boron content, high temperature glass fiber were used to insulate thermocouple lead wires placed in a snout facility at KW Reactor. Both insulation materials operated satisfactorily for approximately one year in-reactor. The only evidence of radiation effects was observed early in the irradiation. At this time the between-lead resistance of the asbestos insulated wires dropped from greater than 10^7 ohms to 10^5 ohms. A gradual recovery of this value to greater than 10^7 ohms occurred in the first 200 hours of the irradiation. Decomposition of organic material in the asbestos is suspected of causing this effect. A report covering this work, "Irradiated Testing of Quartz and Asbestos Thermocouple Insulation" (HW-60095), has been written.

Metallic Fuel Development

Cluster Fuel Elements. Three 7-rod cluster fuel elements were discharged from the ETR 3x3 loop facility after attaining an exposure of 900 MWD/T. These elements operated successfully in 280 C coolant at power levels ranging from 70 to 114 kw/ft. The calculated maximum core temperature was 530 C.

Seven 7-rod cluster fuel elements, fabricated from 1.6 percent enriched uranium coextruded in Zircaloy-2 cladding, were charged into the KER Loop 2 facility. Clad thickness on six elements was 0.020 inch, the seventh element contained a 0.030 inch cladding. These elements are being irradiated to compare the performance of rods of various clad thickness and have a goal exposure of 5000 MWD/T.

A total of four 7-rod cluster fuel elements have been charged into K Reactor through-hole facilities to gain exposure prior to purposely defecting an element at temperature in the ETR 3x3 loop facility. Two elements will reach a goal exposure of 2000 MWD/T, the remaining two will reach a goal exposure of 1000 MWD/T before discharge and subsequent shipment to the ETR.

A variable spaced cluster element was irradiated to 1250 MWD/T in 270 C water. Coextruded Zircaloy-2 clad uranium rods were assembled with triangular end rings. The most closely spaced rods showed the largest diameter increases. The largest increase was from 0.632 inch diameter to 0.640 inch diameter. Other rods had no significant diameter increase. Density measurements do not show a correlation between diameter increase and density decrease. The largest density decrease was observed in a low burnup center rod - 0.5%. Evidently the volume changes measured in this

test are not much larger than the accuracy limit of Radiometallurgy measurement. No warp occurred. The triangular end rings proved satisfactory.

Six prototype fuel elements of the 7-rod cluster type were built during the month. These are built of sub-standard coextruded rod and are intended for charge-discharge and flow tests rather than irradiation. The elements were built to fit a 2.7-inch diameter NPR process tube. Two each of one-foot, two-foot, and three-foot long elements were fabricated. Each element is supported in the process tube by clip type 0.030 inch thick Zircaloy-2 supports attached by resistance welding near each end to the outside six rods of the cluster. The two-foot long element has one intermediate spider support system in the middle of the element, and the three-foot long element has two intermediate support spiders. The elements were assembled readily and accurately by use of a precision holding jig. The self-aligning design of the end spiders also contributed to the ease of assembly. Fabrication of these elements demonstrated the possibility of assembling cluster fuel elements within dimensional tolerances of 0.010 inch on the outside diameter and within a rod to rod spacing tolerance of 0.003 inch.

Tubular Fuel Elements. Tubular element components can be successfully coextrusion clad with zirconium alloy. Nuclear Metals, Inc., has produced about 300 feet of Zircaloy-2 clad uranium tube suitable for KER testing. NMI has also produced 30 feet of tubular fuel with diameters as proposed for the NPR. Eight tube-tube fuel elements of KER size were built during May. They are each 36 inches long and contain about one pound of uranium per inch. Four of these elements will be irradiated in high temperature water at KER. The other four will serve for KER backup and/or ETR high specific power tests. Four of the eight elements have U-2% Zr alloy cores. Two tube and rod elements continue to operate successfully in KER Loop 4, with a current exposure of 1500 MWD/T, and a planned discharge date of July 15.

A tube-tube element was charged into KER Loop 1 during May. This element, containing U-2% zirconium fuel, will be discharged after 250 MWD/T. This is the first tube-tube element to be tested at Hanford KER. The short exposure goal will allow examination to check fuel supports, element warp, and other features of design which could cause trouble early in the test. The distance between fuel supports of the inner tube is about 30 inches, the largest unsupported span yet tested at KER.

A tube-tube element was built and shipped to the ETR for testing in the Hanford 6x9 loop. The specific power of this element will be about 360 kw/ft (80 watts/gm) with the ETR at full power. It is 22 inches long, weighs roughly one pound per inch, and has a U-2% zirconium core. This test is scheduled to begin June 6, and run for three ETR cycles (2000 MWD/T). Maximum core temperature is calculated to be 700 C.

Component Fabrication. Twenty Zircaloy-2, 7-rod cluster spiders of KER geometry have been fabricated by electrical discharge machining on Cincinnati Milling Machine Company's "Elektrojet". The pieces were cut

from 0.200 inch thick plate. Cutting time varied from 8.5 to 15 minutes per piece depending on operating conditions. A competitive machine requires 35 minutes to perform the same cut. A visual inspection shows the "Elektrojet" surface to be equal or superior to that produced by competitive equipment. Dimensional stability is good. The average outside dimension varies by ± 0.002 inch over 20 pieces. Examination of the spark machined edges at 250X shows no perceptible effect on the zone adjacent to the disintegrated surface. Sixty additional pieces will be cut and shipped including the data recorded for each cut, completing the order for eighty spiders.

A die set is now being designed to punch spiders from Zircaloy plate. Preliminary tests with a segment die (two rod bosses connected by a narrow web) show that the segment can be cut from 0.125 inch thick stock. A force of approximately 14 tons was required to shear the segment from 0.125 inch thick Zircaloy-2 ingot material.

Drawing dies, for reducing the OD of Zircaloy-2 tubing, have been made from a glass cloth laminate with a melamine resin binder. This material is better than Textolite since it shows a good deal less wear, is dimensionally more stable, and appears to retain its strength at higher temperatures. Expanding plugs of the same material are being made, and it is assumed that they will do an equally good job on increasing the OD of Zircaloy-2 tubing.

Tubing with an expanded surface has been made by swaging. The surface area has been increased 85 percent by producing eight ribs as an integral part of the tube surface. This technique will be tried on a Zircaloy-2 tube with a uranium core.

Closure and Joining. Hot heading has been performed on 0.780 inch diameter coextruded fuel rods of four-inch lengths with 0.020 inch thick Zircaloy-2 clad. The hot heading is for the purpose of providing a thickened Zircaloy-2 surface at the ends of the rod which is required for one form of welded end closure. The end of the rod is essentially back extruded with a die shaped to extrude the uranium core from the end of the rod while thickening the Zircaloy-2 cladding material and forcing it over the end of the rod.

The results on the 0.780 inch diameter rods compare favorably with the end forming obtained on the smaller 0.630 and 0.593 inch diameter rods previously hot headed, with the exception that the Zircaloy-2 clad material did not completely flow over the rod end and into the extrusion. It is expected that longer extrusion punches will correct this situation.

Equipment for hot heading fuel rods in lengths of 12 inches has been fabricated, and initial testing indicated satisfactory performance. Prior to the use of this equipment the longest rods hot headed were four inches long. If further use of this equipment shows that the fuel rods can be satisfactorily and consistently hot headed, the equipment will be used in hot heading 0.593 inch diameter coextruded Zircaloy-2 clad uranium rods to go into 12-inch long, 7-rod cluster fuel elements. These fuel elements will be irradiated in the KER loops.

In an attempt to prevent seizure of the fuel rod during the hot heading operation, a thin copper jacket has been utilized with success. Jacketing of the Zircaloy-2 clad fuel rod with 0.0005 inch of copper was accomplished by the electroplating technique. The plating bath used was of the alkaline pyrophosphate type using a current density of 30 asf and vigorous air agitation. Pretreatment prior to plating was the two-etchant procedure as outlined in HW-34496.

Coextruded Zircaloy-2 clad natural uranium fuel rods 0.78 inch diameter were acid machined to remove 0.125 inch of uranium from each end. Counter boring of uranium was necessary to facilitate welded end plug closure. Concentrated hydrochloric acid (37-38% HCl) at room temperature was used, and removal rates of 10-15 mils per minute were achieved. Undercutting of the Zr-U bond layer was observed only when the fuel rods were acid machined in a non-vertical position.

Allied Fuel Studies. Strain measurements have been made on the four Zircaloy-2 fuel element jacket burst test specimens which were ruptured at 350 C in the ex-reactor burst testing facility. The measured strains were 3.9%, 3.9%, 8.5%, and 9.2%. Because the wall thicknesses of the specimens were not uniform (the thickness varied as much as six to ten mills in each specimen), the strain was non-uniform and was localized near the thin wall section where rupture occurred. Specimens with a more uniform wall thickness would likely strain more uniformly and would probably show a greater total strain. One specimen was pressurized at a low enough pressure so that it failed by creep, whereas the previous specimens ruptured while pressure was being raised. The previous specimens appeared to have failed explosively while the creep specimen exhibited a very small crack at the point of rupture. Tangential (hoop) stress was 37,000 psi for the specimen which failed by creep as compared with an average of 41,000 for the specimens which failed as pressure was being raised. The total strain measured on the latter specimen was 3.8% which is slightly less than the smallest strain measured on the previous four specimens.

Fuel corrosion rates of defected coextruded rod specimens in the optimum beta treated condition (10 minutes at 725 C, quench and hold 10 minutes at 600 C, air cool) do not appear to differ significantly over the temperature range 200-475 C(autoclave data). Rod specimens defected with a 0.025 inch diameter hole in the cladding corrode at a rate of 0.18 g/min at 300 C in autoclave; both tubular and rod specimens with the same defect corrode at a rate of 0.22 g/min at 300 C in ELMO #4. Although the uranium corrosion rates are the same, there appears to be less clad damage during failure in the dynamic ELMO loop than in the autoclave.

The superior defect behavior of diffusion treated and water quenched coextruded U-2 w/o zirconium fuel rod has previously been demonstrated. A diffusion treated and water quenched specimen was aged for 235 hours at 475 C to determine the effect of reactor temperature conditions on the meta-stable water-quenched bond. The defect behavior of the aged specimen was as good as that of the unaged specimen, indicating good stability of the water-quenched condition at the aging temperature.

Knowledge of the dependence of clad uranium fuel element swelling upon cladding and uranium temperatures, cladding thickness, and exposure is of importance for Hanford's fuel element development work. As a cursory investigation of the effect on swelling of these parameters, an initial irradiation of five experimental assemblies containing Zircaloy-2 clad coextruded uranium fuel is being made in the MTR and ETR. GEH-3-32 and GEH-3-57, the second and third of the above fuel rods to be discharged, will be returned to Hanford for examination before the end of May. Exposure on these fuel rods is 3500 MWD/T and 1900 MWD/T, respectively. The remaining two fuel rods in the ETR have reached an exposure of approximately 1800 MWD/T.

To extend the coverage of the temperature, exposure, and cladding restraint parameters, twelve more assemblies, similar to those now in the ETR, are being prepared for irradiation in the MTR. These will be ready for charging by June 15.

To attempt a statistical analysis of the effect of temperature, exposure, and cladding upon fuel rod swelling, a series of NaK capsule experiments has been designed for irradiation in Hanford reactor process tubes. Assembly of these capsules has started. It is planned to begin the irradiations in July.

Design Analyses and Computations. The mathematical models for swelling within irradiated uranium require knowledge of the amount of inert gases produced by fission. The amount of gaseous production in the final products depends upon the material fissioned and the neutron flux intensity during irradiation. The inert gaseous fission products vary for uranium from 5.27 to 6.28 - (cc / cc · % burnup) at STP - and for plutonium from 3.69 to 4.48 - (cc / cc · % burnup) at STP - as the flux varies from 10^{13} to 10^{15} [neutrons/cm^2 - sec]. Yields and their flux dependence of the various fission product isotopes which produce krypton and xenon are reported in HW-60431.

Facilities and Equipment. The in-reactor section of the 6x9 ETR Loop was installed May 15, 1959, and the loop is currently being operated to measure gamma heating. Fissionable material can be loaded the next operating cycle of the reactor. This completes the 6x9 facility according to Project CA-681. The 3x3 Loop still must undergo extensive modifications to permit intentional in-reactor ruptures. Present scheduling should complete the entire project about October 1, 1959.

A Dynapak machine that extrudes at velocities to 200 fps and at an output energy of 160,000-foot pounds was installed in the 326 Building as prototype equipment. This unit will be used to check the hydrodynamic behavior of materials when they are worked at high velocities, with high rates of energy application.

2. REACTOR PROGRAM

Coolant Systems Development

Corrosion of X-8001. The test to determine the corrosion characteristics of X-8001 fuel element cans made from cast blanks was completed after approximately nine weeks exposure in the out-of-reactor mock-up tubes. Visual inspection showed no adverse corrosion. Corrosion rates will be determined as soon as weight loss measurements are completed. However, on another lot of X-8001, severe groove-type pitting has been observed on the X-8001 aluminum cladding of an I & E fuel element. This piece was discharged from D Reactor at goal exposure. Although there were no in-reactor rupture indications, several pits on this fuel element jacket appear to penetrate to the AlSi bonding layer, and in some places to the compound layer. The fuel element will be sectioned to determine pit depth and to look for "stringers" in the cladding.

Tests in KER In-Reactor Facilities. During the KE Reactor extended outage of April 15 to May 7, extensive maintenance and overhaul work was accomplished on the pumps, valves, and instrumentation of all four KER Loops, including the installation of resistance temperature detectors for more accurate measurement of inlet and outlet temperatures. Horizontal and vertical traverses were made of the process tubes of Loops 2 and 3, and a vertical traverse only was made on Loop 1.

The cause of the recent flow restriction in Loop 1 was found and corrected. The holes in the diffuser ring of the front nozzle were found to be badly clogged with crud. The strainer just upstream of the front face was found to be damaged to the extent that solid material could pass through.

At the end of the extended outage Loops 1, 2, and 3 were charged with aluminum dummies for a short shakedown run. Loop 1 was recharged May 19 with two 13-inch, 7-rod clusters (one natural U and one 1.6% enriched), one 36-inch tube-and-tube element, and one 33-inch rod-and-tube element, all Zr-2 jacketed. The two tubular elements contain natural U with 2 w/o Zr. Loop 1 continues at pH 10, with a maximum allowable surface temperature of 295 C.

Loop 2 was charged May 19 with seven 1.6 % enriched 7-rod clusters, six with 20-mil and one with 30-mil Zr-2 jackets. All these pieces have modified end supports. A 7-rod thermocouple dummy was included at the downstream end of the charge to measure water temperatures in different flow channels and thus determine the degree of mixing of the water. Six of the seven thermocouples appeared to be functioning properly and showed water temperatures within a range of 18 C, indicating fairly good mixing.

Loop 3 was charged on May 25 with five Doe metal slugs canned in X-8001 aluminum and 15 Doe metal slugs canned in C-810 aluminum (1.0 w/o Ni, 0.5 Fe, 0.1 Ti; i.e., essentially X-8001 with Ti added). After the loop surfaces are conditioned with a phosphate film, this charge will be replaced with Doe metal slugs all jacketed with X-8001 for a high temperature jacket corrosion test.

Decontamination. A program has been formulated to develop a suitable method of decontamination for the NPR, and a summary of the decontamination studies completed during the past year is in preparation. Also, the state of the technology as it exists today for NPR decontamination facilities has been summarized to stimulate feed-back between the design concepts for NPR decontamination facilities and the supporting Research and Development program.

Water Treatment. Preliminary studies were initiated to determine the pH control characteristics of the high pH, lithium hydroxide resins with high purity water feed. Results to date indicate that the lithium-to-hydrogen ratio on the resin quickly reaches a critical value and the pH stabilizes at about 8.2-8.5. A weakly acidic resin (IRC-50) is now on order. This resin is selective for hydrogen. The two resins will be used in parallel in an effort to control the final water pH at 10.0.

Heated Slug Rupture Tests. The coextruded uranium and Zircaloy-2 rod in the as-extruded condition, which previously had been tested for 1/2 hour, was operated for two additional 1/2-hour exposure periods. Test conditions were 300 C water temperature, 1650 psi, power rate 30 kw/ft, and 20 fps water velocity. The jacket was initially defected with three 0.025 inch pin holes, about 1-1/2 inches apart. After the total 1-1/2 hours exposure, the appearance of the rod was similar to those tested in ELMO-4 without power generation. Each of the defected spots exhibited swollen and torn mounds about 1/2 inch in diameter plus a 3/4 inch long tear along the axis of the rod. The maximum diameter of any of the defected locations was 0.79 inch compared with the original 0.59 inch rod diameter.

The coextruded rod holders, lead-in bus rod, and the surrounding process tubing arrangement on this electrically heated rupture prototype have been redesigned to permit faster assembly and disassembly. The new design also eliminates the troublesome brazed joint between the Zircaloy-2 and copper adapter piece.

Corrosion of Zircaloy-2. A test to determine the corrosion resistance of Zr-2 welds in pH 4.5 300 C water has been completed. Heliarc and electron-beam welded coupons were subjected to the following various pretreatment conditions: (a) as-received, (b) as-received plus Turco 4501 decontamination process, (c) as-received plus APACE decontamination process, (d) polished, (e) etched, (f) etched plus Turco 4501 decontamination process, and (g) etched plus APACE decontamination process. On inspection after exposure in 300 C water the coupons which were etched after welding exhibited tight black corrosion product films. All non-etched coupons except those in the as-received condition developed white corrosion product at the edges of the heat affected zones. Numerous areas of hard white corrosion product were found scattered over the heat affected zone on the as-received coupons. These white areas were about one-tenth the size of a single Zr-2 grain. They were found both in the grains and at the grain boundaries. One to five of these small areas were found on the

other coupons including the etched coupons. However, they did not grow in size with increased exposure and did not appear to affect the corrosion resistance of the welds.

Several devices are being fabricated for the study of fretting or wear corrosion of Zr-2. These will attempt to (a) produce such attack, and (b) establish whether contemplated fuel element designs will be subject to fretting corrosion under anticipated operating conditions.

Heat Exchanger Tests. Design of a stress-corrosion heat exchanger was completed, and fabrication will begin as soon as all the parts are available. This equipment will be employed to study stress corrosion, caustic embrittlement, and surface boiling on heat exchanger tubes under NPR conditions.

Corrosion in Organic Coolants. The coupons which were previously exposed in ORA-1 at 700 F for 28 days in MIPB containing 20 ppm water, then for 1-1/2 hours with the water content increased to approximately 10,000 ppm were examined and weighed. The British Magnox underwent a corrosion rate of about 1.5 mils/month, the 98.8% Mg about 2 mils/month, and the AZ-31 alloy about 3 mils/month. This compares with an expected 1 mil/month for all three alloys in MIPB at 700 F with only 10 to 20 ppm H_2O. The carbon steel and M-388 aluminum coupons were virtually unaffected.

Four fuel elements, two solid, 25 clad lead-dipped, and two I & E M-388 clad-nickel-bonded, were discharged from ORA-1 after 1265 hours in MIPB at 700 F. The 25 lead-dipped slugs exhibited a light brown adherent film while the M-388 clad had no film at all over most of the surface, except for black spots covering about 5% of the area. These spots were not removed by the usual solvents and brushing.

Aluminum Corrosion. The ELMO-6 Loop was charged with X-8001 coupons, X-8001 clad Doe slugs, and C-810 clad Doe slugs. The C-810 alloy is essentially X-8001 (e.g., 1.0 w/o Ni, 0.5 Fe) plus the addition of 0.1 w/o Ti. The coupons and slugs will be exposed to 300 C pH 4.5 water adjusted with H_3PO_4. These coupons will then be exposed to 400 C steam to determine whether the 300 C corrosion film is protective. The slugs will be defected and exposed to 400 C steam to determine the rupture severity of Doe metal under KER conditions. Another facet being studied in this test is the changes which occur in the structure of the corrosion product film when coupons are cycled from static conditions to dynamic conditions and vice versa.

Nickel-plated X-8001 clad dummy slugs were charged into ELMO-7 to evaluate the corrosion resistance and filming characteristics of this material in 300 C pH 7 water. The material consists of electroplated and chemplated dummies processed by two vendors with nickel thickness varying from 1.0 to 1.3 mils.

Exposure of nickel-plated C-64 clad fuel elements at 300 C, pH 7, showed a tendency for spalling at the edges of the elements, although the chemically plated material held up better than electroplated material. The

electroplated material appeared more ductile and probably would be a better cladding if properly plated on the base metal.

Structural Materials Development

Zircaloy Pressure Tubing. Zircaloy-2 pressure tubing is being tested to failure with internal pressure at elevated temperatures. The test temperatures are selected to approximate the maximum tube surface temperatures to be encountered during operation. Three lengths of KER tubing and one length of NPR tubing were vacuum annealed and tested at 650 F (343 C). Pressures of 7200 to 8500 psi were required to burst the tubing.

The KER tubes expanded uniformly along the length of the sample to 12.5% increase in diameter. Local bulging up to 69% increase in diameter preceded fracture. The fracture progressed axially for about four inches before the ends turned transverse to the axis for one-half to one inch.

Failure of the NPR tube occurred prior to any localized bulging. A small crack 5/16 inch long appeared on the oustide surface, with the long axis of the crack oriented at 30 degrees with the axis of the tube. Considerable localized necking was apparent in the vicinity of the crack. Upon examining the inside surface of the tube, the crack was found to be 9/16 inch long. The inside surface exhibited flow lines that formed parallelograms with 60 degree and 120 degree included angles. Short cracks were found at intervals along these lines. Although the pattern may have a mechanical origin, the symetry strongly suggests a relationship to the hexagonal crystal structure of zirconium. By means of these and related studies it is also hoped to shed some light on the failure mechanisms of Zircaloy-2 tubing.

Creep of Zircaloy-2. A contract with Battelle Memorial Institute to continue creep testing of Zircaloy-2 has been approved. Under this contract BMI will continue creep testing of annealed and 15 percent cold worked Zr-2 under constant stress - constant temperature and constant stress - cyclic temperature conditions. One temperature cycling test has been completed on 15 percent cold worked Zircaloy-2. The temperature cycle used was six days at 650 F - one day at room temperature. In the early part of the test, a small amount of primary creep occurs with each temperature cycle, but the magnitude decreases with increasing number of temperature cycles and is indistinguishable beyond about 100 cycles. Total creep strain is comparable to that observed in a constant stress-constant temperature test.

Nonmetallic Materials Development

Irradiation of Candidate NPR Graphites. A new experimental facility in the 2-C test hole at KE Reactor has been completed for graphite irradiations in the temperature range of 500 to 600 C. The initial charge consists of six graphite spacer boats in the reflector region of the test hole and eleven sample-carrying boats in the central region. The spacer boats, fabricated from Texas coke AGOT graphite were measured to provide data on dimensional changes in the fringe regions. NPR candidate graphites

were used for the sample-carrying boats, and it is expected that measurements made on these boats will provide a direct comparison between full-bar and samll-sample results. The candidate NPR graphite samples charged include three from National Carbon Company (VC, VT, and 00), two from Speer Carbon Company (SP-9 and SP-10), and two from Great Lakes Carbon Company (GL-10 and GL-11). CSF, KC, and TSGBF graphite samples were also included as standards for comparison. Samples were annealed at 650 C prior to charging to reduce the effects of compression set. Goal exposure for the charge is 1000 MWD/AT with the exception of one boat which will be discharged with approximately 600 MWD/AT. Removal at this lower exposure will permit a comparison of annealed and unannealed samples at an exposure where the maximum expansion has been observed for samples irradiated at temperatures above 300 C. From these data it will be possible to determine to what extent the initial expansion found at low exposures in 400 to 500 C irradiations is a result of thermal annealing of compression set.

The first irradiation results for NPR candidate graphites have been obtained from samples discharged from the Y test hole at C Reactor with approximately 700 MWD/AT at 500 C. These samples, extruded in two-inch rounds or in 10 to 16-inch diameter electrode stock, were the earliest available for irradiations and do not represent processing entirely typical of the final NPR graphite. However, in comparing the differences in behavior of the several candidate coke types, Continental coke graphite samples from a two-inch round extrusion showed the highest expansion (+0.054 percent) of samples cut transverse to the extrusion axis and were the only samples to contract (-0.007 percent) in the direction parallel to the extrusion axis. The high transverse expansion is indicative of a graphite which exhibits a relatively low contraction on irradiation at 500 C. Ohio and Socony Mobil coke graphites in expanding 0.045 percent in the transverse direction and 0.010 percent in the parallel direction behaved very similar to standard graphite made from Texas coke.

Thermal Expansion of Graphites. Thermal expansion coefficients of reactor graphites are of particular interest because of an apparent correlation with contraction rates when irradiated at high temperatures (e.g., 500 C and above). KC graphite, which exhibits the lowest contraction rate of any graphite yet tested in irradiations at 500 C, has a high thermal expansion in the transverse direction and a relatively low thermal expansion parallel to the extrusion axis. This combination, i.e., a high ratio of transverse-to-parallel thermal expansion coefficients, is now believed to be characteristic of graphites with good dimensional stability on irradiation at high temperature. The high transverse coefficient is in itself not a sufficient criterion since poorly oriented graphites, which exhibit high contraction rates on irradiation at high temperature, have high thermal expansion coefficients in both the transverse and parallel direction. Thermal expansion data for typical graphites are listed in the following table.

Graphite Type*	Manufacturer	Average Thermal Expansion Coefficients Over Range 25 to 425 C: Transverse	Parallel	Ratio: Transverse/ Parallel	Relative Dimensional Stability on Irradiation at 500 C
KC)	National	4.7×10^{-6}	1.2×10^{-6}	3.9	Good
CSF)	Carbon	3.5	1.5	2.3	Intermediate
TSGBF)		4.4	2.7	1.6	Poor
VC)		3.5	1.1	3.2)	Being deter-
GL-10	Great Lakes	3.8	1.2	3.2)	mined
GL-11	" "	3.5	1.2	2.9)	

*These graphite types are further defined in HW-58946.

If KC graphite is no longer available, the VC, GL-10 and GL-11 graphites are considered the three most promising graphites now undergoing evaluation for NPR use. However, since a considerably larger coke particle size was used in processing these three new graphites than was used for KC, the National Carbon Company has agreed to produce samples on a developmental scale using the same Continental coke as in VC but with an all-flour mix. It is believed that this change will increase the transverse/parallel thermal-expansion ratio still further and may result in a graphite with superior stability to dimensional changes on high-temperature irradiation.

In-Reactor Compression Test of Graphite. Four graphite compression test assemblies to determine the effect of loading on the high-temperature radiation-induced contraction of graphite were charged into test hole 2-C at KE Reactor. For each of the four types of graphite, CSF, TSGBF, KC and VC, three samples were loaded at 160 psi and four samples at 80 psi. Eight unloaded samples were included as controls, one at the position of each loaded sample. In addition to the compression-stress loaded samples, some information on the influence of flexural stress will be obtained. Six samples, which are actually part of the experimental mechanical assembly, contain platinum pins inserted in a rectangular configuration. Any changes in the interpin spacings will be measured to determine the effects of flexural stress on radiation-induced dimensional changes. Al-Co and Ni foil monitors have been included to measure the flux distribution in the test hole.

ETR Graphite Irradiations. The first in the GEH-13 series of graphite irradiation experiments was successfully installed in the N-14 corner filler position of the Engineering Test Reactor the week of April 26. Maximum sample temperatures, which varied from 665 C to 780 C along the capsule length, were reached during the few hours the reactor has operated at full power.

Because these temperatures in GEH-13-1 are lower than desired, the samples for a second capsule to be charged into the ETR E-5 corner filler position have been modified to attain an estimated sample temperature between 1000 to 1100 C. The new experiment will also contain powder samples of various graphites, and some small rods of special high density impermeable graphites.

MTR Graphite Irradiations. Installation of the first graphite test in an instrumented MTR shim rod (L-48) was successfully completed on April 29. The unit is functioning satisfactorily as a reactor control rod, but the electrical connector to the irradiation experiment requires further development to be completely reliable. As of the middle of May, control at near-goal temperatures of 720 C, 610 C (intermittent), 975 C, and 980 C had been attained at the four sample positions.

The GEH-9-8 capsule was discharged from the L-42 position after successfully completing five MTR operating cycles. This represents the highest exposure attained to date in these experiments. GEH-9-9 containing four samples of VC graphite was charged for a one to three cycle exposure. VC graphite is one of the three prime candidates for construction of the NPR core.

Thermal Hydraulics Studies

Equipment Projects. The equipment installation was completed on the project to provide additional heat generating capacity in the 189-D Heat Transfer Laboratory through the use of silicon rectifiers (Project CG-661), and the equipment was operated at low power levels under the direction of the vendor's representative. Areas were defined which require minor adjustments before the acceptance tests are performed.

The project to modify the High Pressure Heat Transfer Apparatus for higher flow and heat generating capacities and to allow transient type experiments (Project CGH-834) is on schedule. The 250 gpm pump was received after the successful completion of a 100-hour hot test at the vendor's plant. Shop fabrication was started on the bus bar additions to handle 32,000 amps and the bus intertie to connect the apparatus with either the rectifier or generator heat generating source. In addition, the construction forces commenced site preparation for the test section fabrication area.

Hydraulic Studies. A flow restricting device was developed and tested which will fit into the downstream end of a K Reactor process tube. The device is proposed for use at the K Reactors with the K-III I & E slugs (a low flow resistance slug) during five-pump operation. Five-pump operation would be non-standard procedure with K-III slugs, but if one of the six pumps should fail and be out of service for an extended period, then the use of this flow restricting device might be economical for such interim operation with five pumps.

The device, which is to replace the two downstream thin wall perfs, was sized to provide an additional 55 psi of pressure drop at a specified flow rate. It was found that critical flow and temperature monitoring characteristics would not be changed during its use. Results of the development tests are presented in HW-60375.

Channel flow split ratios were determined for a model of a developmental tube-and-rod fuel element which is presently being irradiated at NRTS, Arco. The experimental flow split values checked well with previously calculated values, but these did not compare well with thermocouple readings obtained during irradiation. It is now suspected that the thermocouples may be in error.

A model of the 7-rod cluster fuel assembly for NPR, using 0.704-inch diameter rods, has been fabricated and assembled. This assembly is approximately six feet long and will be used in hydraulic studies of ΔP versus wire wrap pitch. Copper wire has been drawn to the proper size to use in wire wrapping at various pitches. Initial experiments were performed without any wire wraps.

A special coaxial type copper conductor was received to be used in the measurement of mixing efficiency by conductivity methods in a 7-rod cluster type fuel element. Although installation of the cable proved satisfactory and did not disturb flow, initial experience with the electrical circuit indicated unstable and unpredictable resistance values.

Heat Transfer Characteristics of NPR Type Fuel Elements. The calculations of the natural mixing efficiency for the 7-rod bundles were extended to include fuel rods of diameters 0.625, 0.704, 0.740, and 0.780 and lengths of 10, 20, 30, and 40 feet. This work was completed, and a final report was written (HW-60376).

Mechanical Equipment Development

Organic Cooling System Components. The shaft seals using John Crane Sealol and Durametallic have operated 1304, 1576, and 1414 hours, respectively. Various test pieces were operated for 480 hours during May at 300 C and 300 psi with a recirculated tertiary organic eutectic. A total operating time of 1200 hours has accrued with the above organic.

Reactor Technology Development

Attenuation Measurements. The foils from the final test on ferrophosphorus concrete baked at 320 C have been counted and the data sent to IBM. This will complete the program for testing neutron and gamma attenuation properties of ferrophosphorus concrete. A summary report on the ferrophosphorus concrete program is in preparation.

Foils from the second test on pure iron have been counted and the data sent to IBM. The data from the ordinary concrete program are being analyzed. The perforated ferrophosphorus concrete test slabs are being baked at 50 C. Two new sets of concrete test slabs are being fabricated, (1) using a serpentine mixture and (2) using a barite mixture.

Counting is under way on the first foil loading of the NPR boron-steel thermal shield test.

3. FABRICATION DEVELOPMENT - SPECIAL ALUMINUM-PLUTONIUM FUEL ELEMENTS

Approximately 200 billets (600# of aluminum-plutonium alloy) have been cast for the experimental fabrication of fuel elements for SRP irradiation. The billets were cast to the correct diameter with one

end configuration in order to eliminate as much machining as possible. With a nominal Pu concentration of 7.35 percent, the analyses of the cast billets have been in the range of 7.06 to 7.58 percent Pu, or within four percent of the nominal composition.

A boron pick-up of 100 ppm was detected spectrographically in some of the billets. This coincided with the use of clay graphite crucibles for melting. Analyses of the crucible material have indicated a surface layer containing 200 ppm boron, but a boron concentration beneath the surface of only 3 ppm. Also, a cutting lubricant which is carried along with the remelt stock, contained 2 ppm boron. However, assuming these samples are representative, the amounts of boron detected in the crucible and lubricant are insufficient to explain the amount of contamination in the alloy. Hence, this boron contamination problem is being investigated further.

To date, seventy-five transplutonium fuel rods have been extruded. The as-extruded rods are approximately 72 inches long with 57 inches of Al-Pu core material containing the nominal 7.35 w/o Pu. The extruded diameter is 0.940 inch, and the X-8001 Al cladding thickness is approximately 0.100 inch. The extrusion temperature is 525 C, and the average extrusion pressure is 6.2×10^4 psi. Two principal causes of rejects in the earlier extrusions were blisters and "dogboning", or end effects. The blister reject rate was decreased by modifying the billet design to minimize restriction of the outgas hole during welding. The "dogboning", which was greatest at the lead end of the core, was decreased to within specifications by machining a taper on the lead end of the billet core.

To date, a total of 33 acceptable elements have been shipped to Savannah River for irradiation to high burnups. An additional special element, sectioned at the center and closed with 0.010 inch aluminum foil, was also shipped.

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.

DECLA[redacted]

C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels Development

Basic Studies. Experiments to determine the effect of plutonium dioxide additions on the sinterability of UO_2 have continued. PuO_2 has been added to ball milled PWR grade UO_2 as a physical mixture, and in the form of the mixed crystal oxide. Conclusions which may be drawn to date are:

a. The sinterability of UO_2 is markedly reduced by physical additions of up to 10 w/o PuO_2. This is evident from data at one, two, four, and eight hours from 1100 to 1600 C.

b. After eight hours at 1500 and 1600 C, densities of the mixed crystal (rather than physical mixtures) are equivalent to, or above, that of UO_2. This may possibly be attributed to solid solution formation.

c. PuO_2 added to UO_2 in the form of the mixed crystal oxide appears to slightly increase densification rates.

d. A preliminary value of the activation energy for self-diffusion in UO_2 was determined as 75,000 cal/mole.

Turnings of alpha and delta plutonium metal were heated with 6% excess carbon at 1050 C and 10^{-4} mm Hg for 3-1/2 hours. There was a definite fusion of the two constituents into a porous mass which was very pyrophoric. X-ray diffraction patterns of the two samples showed the phases PuC, Pu_2C_3, and some residual carbon. In addition, the mixture containing alpha plutonium gave an unidentified phase.

A high temperature tungsten ribbon furnace has been put into operation for use in melting point determination of compounds. Uncorrected temperatures on the order of 2600 C have been attained. At this time the pyrometer absorption corrections are being determined.

The experimental work on solid solubility in the system UO_2-PuO_2, and on chemical dissolution of solid solutions formed during sintering in this system, has been completed and is reported in HW-60276.

The radiometallurgical examination of the unbonded 4-rod, Al-Pu alloy cluster (IP-186A) irradiated in the KER-3 Loop is almost completed. An eight-inch long, Al - 8 w/o Pu alloy core elongated 0.008 inch, while two, four-inch long cores shortened in length by about 0.009-0.010 inch. Two of the four-inch long cores were found to be diffusion bonded to each other but not to the Zircaloy cladding.

Fabrication Studies. The Al-Zr metallurgical bond formed by air-pressure injection casting of aluminum into Zircaloy tubing was completely broken when two, 32-inch long, simulated fuel rods were autoclaved for 72 hours at 400 C and 1300 psi. Before autoclaving, Zr end caps were welded into the counterbored tube ends so that there was no clearance between the aluminum cores and the end caps. After autoclaving the ID of the tubing was as much as 0.002 inch greater than the OD of the aluminum cores. Longitudinal tubing elongations of 0.028 and 0.032 inch were noted after autoclaving, and the aluminum lengths were as much as 1/8 inch shorter with consequent increase in density.

A 48-inch long injection cast rod was held at 400 C in a vacuum furnace for one hour and then slowly cooled in the furnace. End caps were not used with this casting, and no dimensional changes were found after the furnace treatment. Metallographic examination at 500X of the Al-Zr bond before and after heating in the vacuum furnace revealed that the bond did not separate as in the autoclave and that one phase in the layer had grown at the expense of another. The Al-Zr compounds in the layer were not identified.

Stainless steel cans filled with fused alumina powder have been successfully reduced up to 40% reduction in area by rolling. This has resulted in a calculated ceramic density of 75%. The experiment is being repeated using sized particles which have been outgassed and then vibration packed. After a 25% reduction the plates will be annealed, and an additional 25% reduction will be taken. Although it is hoped that 90% of theoretical density can be achieved, it may be necessary to change can design and to evacuate the cans in order to reach the desired density.

A 7-rod, Zircaloy-clad, Al-Pu cluster has been completed and sent to the ETR for irradiation, and the fabrication and assembly of a 19-rod cluster experiment are proceeding on schedule. Nineteen-rod clusters are being fabricated by using the anticipated PRTR fuel fabrication process, which is to insert undersized rods into as-received Zircaloy tubing followed by sizing the sealed tube onto the rod by swaging.

One of the full length Zircaloy clad and wire wrapped dummy elements that had been fabricated by swage sizing was cycled 1650 times in the ELMO loop between 250 and 525 F. The thermal conditions in the loop were quite severe in that a considerable temperature gradient (150-200 F) existed along the length of the element during cycling, and the rate of rise and fall was about 150 to 200 F/min. An examination of the element showed that it had failed by splitting of the cladding along the full length. Since the element was not examined intermittently, it is not known how many thermal cycles were sustained before the rupture occurred. The wire remained intact, however, and the rupture was not caused by an end closure failure. Further cycling experiments are planned employing additional elements with intermittent examinations.

Two similar defected elements which contained 2S Al rods were also exposed to 300 C, PH-9 water, in the loop for a total of 30 hours. A surface flow velocity of 15 ft/sec was maintained throughout the experiment. One

element was defected by drilling 1/16-inch diameter holes through the cladding near one end and at the center. Corrosion products were visible through the holes; however, the element showed no signs of swelling at the end of this time, and the test was discontinued. The other element was defected on one end with a five-inch long longitudinal slit through the cladding. The width of the slit was about 3/64 of one inch. Although a slight amount of swelling was observed in this element after eight hours exposure, the swelling was no worse after 30 hours. These elements were cycled a total of four times between room temperature and 300 C at the rate of about 50 F/min. Some warping of the elements was observed; however, a temperature gradient existed along their length. No loosening or fretting of the wires was observed. The elements are now being sectioned to determine the extent of the aluminum corrosion.

An existing wire wrapping fixture has been modified to handle etched fuel rods and wire. Nylon or aluminum was substituted for all brass parts of the fixture to avoid scoring the etched parts and an improved means of pulling the wire in tension was added. The latter change includes a force gage to measure the tension in the wire accurately.

The shop is presently fabricating a banding tool for banding fuel element clusters and a prototype air operated unit for removing the top bracket of a Mark I-F fuel element cluster remotely.

Delivery of sixty, 24-inch, critical mass experimental test elements was made to Critical Mass Physics.

Thirty-three grams of PuO_2 were classified into five different particle size ranges by employing a sedimentation technique in an aqueous solution to which a deflocculent had been added. A good separation was effected by allowing the particles to settle a known distance for various times.

UO_2 Fuel Development

PRTR Fuel Elements. Preparation of approximately 1200 pounds of arc fused UO_2 at Norton Company was completed. If complete evaluation reveals that this material is of the quality indicated by preliminary analyses (particularly O:U ratio) at Norton, this will be a development of significant interest for the preparation of both swaged and vibratorily compacted fuel elements for PRTR testing. The second 19-rod fuel element was assembled this month, and more rods are ready for assembly. The wire wrapping machine was used very satisfactorily for this second fuel element. The total number of acceptable rods produced is approximately equal to the total rejected, with cladding defects accounting for most of the rejects. The cladding defects are detected principally by the fluorescent dye penetrant test (external flaws) or the eddy current test (internal flaws).

Although it has been anticipated that a variety of problems would be encountered in experimentally fabricating and assembling the first full length PRTR rods, a vigorous effort is being made to reduce the reject rate while, at the same time, increasing the number and severity of nondestructive tests which will cause rejects.

A number of rods rejected by the Zyglo (fluorescent dye penetrant) test were sectioned, and small cracks were detected at positions predicted by the dye penetrant. Other areas were free of cracks. This established that the test was adequate and necessary.

Tests of tubing before and after swaging established that many defects were present in the tubing before swaging. To use the tubing on hand without wasting time and materials swaging defective tubes, the acceptance inspection for tubes has been changed from a "dye-check" test to the more critical "Zyglo ZL-22" penetrant test.

A second category of rejects was due to low density material which involved about 22 rods. The cause of the low density was traced to powder preparation problems. Preparation procedures have been changed to increase the density of the UO_2, and more frequent sampling of batches of UO_2 powder is now required.

Fabrication Development. Experiments in which large reductions in cross section were achieved by swaging hollow thin wall tubing sometimes resulted in serious cracks or other defects in the tube. A series of swaging experiments has demonstrated that reducing the "throw" of the dies on the stationary spindle swage machine helps to minimize these defects. The stationary spindle, Sutton swage machine (now on order) has dies having a "throw" which is adjustable from 0 - 0.040". This equipment should make it possible to obtain the optimum die "throw" for any particular swaging job.

The effect of CaF_2 on the densification of sintered UO_2 is being evaluated. Sintering tests at 1750 C for 12 hours showed no beneficial effect with ball milled PWR-type powder. With high percentages (2.5 to 5.0 w/o) of CaF_2, however, the sintered density of untreated PWR grade UO_2 was increased substantially. Densities 95 percent of the theoretical density of UO_2 were obtained with additions of 2.5 w/o CaF_2 to the UO_2 which had not been ball milled.

A heat sensing device providing rapid response is required to adequately control the heat source for hot swaging of fuel rods. A PN germanium-junction photo diode sensing unit is being used to control the heating of fuel rods prior to hot swaging. The device is designed to control temperatures from 200 C to well over 1100 C. Response time of the sensing unit is 0.000001 second. Sensitivity of the device was increased by limiting its response to infrared radiation, thus eliminating the need for filters.

Metallographic examination of hot swaged, Zircaloy-2 clad fuel element rods reveals a microstructure not apparent in cold swaged tubes. The predominant "basket weave" or Widmanstatten-like microstructure which is observed in the hot swaged jacket material is transformed beta phase. As Zircaloy-2 is cooled from the beta phase region (above 900 C) alpha phase platelets precipitate along the crystallographic planes within the large beta grains. The "basket-weave" microstructure results. Corrosion resistance and tensile properties of this structure appear to be as good as, or better than, those of annealed material.

The Zyglo test was employed to check Zircaloy-2 tubes for surface irregularities prior to swaging. Ten of the fifteen tubes tested showed defects sufficient for rejection. All of these tubes had previously passed the Dye-check test. Metallographic examination of the defect areas is in progress. Preliminary data indicate that surface cracks missed by Dye-check and detected by Zyglo are 0.003 to 0.006 inch in depth. These cracks and defects act as stress localizers during subsequent swaging operations and may contribute to cladding failure.

Ultrasonic inspection of defective tubes has been successful in that the Zyglo defects have been readily found. Other defects, possibly imperfections of the internal surface, also were located.

"Hi-fired" UO_2 powder (Spencer Chemical Co.) was swaged to 89-90 percent of theoretical density of UO_2. This compares with densities of 90-91 percent of the theoretical which have been obtained with Norton arc-fused UO_2.

Fuel Evaluation. A fuel assembly consisting of a nested tube and rod of UO_2, 36 inches long, was irradiated in the ETR for six days prior to a fission break. The elements were discharged after five days of irradiation and reinstrumented for additional temperature measurements. The element released fission gases soon after reaching full power after the recharging. Coolant temperature and flow measurements were obtained prior to failure.

A cross section of the irradiated, large diameter (1.44 inches), swaged fuel element containing natural UO_2 revealed the following preliminary data: (1) a thin layer of UO_2 powder adjacent to the stainless steel cladding, (2) a thick cylinder of high density, sintered UO_2, (3) a cylinder of radial columnar grains, and (4) a core containing UO_2 which probably was molten during irradiation. There is a marked similarity between the appearance of the original, irradiated "ash cans" and this swaged element.

Post-irradiation examination of the Pu-enriched, UO_2 powder containing fuel clusters has revealed the following information:

(1) The physical characteristics of the PuO_2-UO_2 fuel after irradiation were markedly different from those of any previously irradiated UO_2, the former exhibiting relatively little of the cracking and fragmentation observed in pure UO_2.

(2) The formation of a large central cavity was evident in both the Pu and the U-235 enriched UO_2 rods. In one of the Pu enriched rods, a solid compact of fuel was formed at one end. Large, tubular oriented voids were observed at the center portion of this compact. Small lateral voids were observed near the termination of the columnar grains. These voids are characteristic of those formed during UO_2 dendrite formation by sublimation in ex-reactor experiments.

(3) Most of the core material after irradiation consisted of large, radially oriented, columnar grains.

(4) Etch pits were formed in the high density columnar grains during polishing and etching.

(5) A second phase of undetermined composition was observed within the large grains of PuO_2-UO_2.

A four-rod cluster containing arc fused, natural UO_2 vibratorily compacted to 78 percent of the theoretical density has been irradiated to approximately 800 MWD/T in the GEH-4 facility in the MTR, at a power generation of approximately 35 kw/ft and a heat flux of approximately 250,000 BTU/hr/ft^2.

Basic Studies. Radiation damage in UO_2 is being studied by metallographic examination of polished and etched surfaces and by fractography. The presence of small voids has been detected at grain boundaries in UO_2 irradiated to 0.015 a/o burnup. The holes presumably arise from (1) migration of gases trapped during the fabrication processes, (2) generation and migration of fission gases, or (3) a combination of (1) and (2). Examination of material irradiated to 0.022 a/o burnup is expected to reveal trends in the radiation behavior of UO_2.

Corrosion Studies

Hydriding of Zircaloy-2. Laboratory studies indicated that the extent of hydriding of Zircaloy-2 when exposed to molecular hydrogen depends on the temperature, the previous ZrO_2 film present on the metal, and the concentration of water vapor in the hydrogen.

Zircaloy-2 samples were prepared by pickling 1" x 1/2" coupons in HNO_3-HF. The surface oxide was dissolved into the metal by vacuum annealing the samples at 700 C. The temperature was then lowered to the test temperature, water vapor at a fixed vapor pressure was admitted to form a new oxide film, and then hydrogen gas was admitted. The hydrogen was valved off and the extent of hydriding measured by the hydrogen pressure drop with time. The data, summarized in Table I, indicate that at 400 C very small amounts of water vapor inhibit the hydriding reaction. As the temperature is raised and the protective ZrO_2 film begins to dissolve into the metal, more water vapor is needed to inhibit the hydriding reaction. It appears that as the ZrO_2 film grows in thickness it becomes less protective. This is indicated by the fact that at both 500 C and 700 C water vapor pressures which were inhibiting at short times were not protective at long times as shown in Table II. Also, a preformed autoclave film hydrided immediately.

TABLE I: HYDRIDING OF ZIRCALOY

Short Term Experiments (Min.)

Temp.	H_2O Vapor Pressure mm Hg	Extent of Hydriding	Time
400 C	10^{-7}	Complete	44 min.
	0.1	Not detectable	38 "
500 C	10^{-7}	Complete	15 "
	0.1	Complete	26 "
	0.6	Partial	50 "
	1.6	Not detectable	50 "
600 C	10^{-7}	Complete	5 "
	0.1	Complete	13 "
	0.6	Almost complete	30 "
	4.6	Not detectable	30 "
700 C	10^{-7}	Complete	4 "
	0.1	Complete	5 "
	0.6	Complete	30 "
	4.6	Partial	30 "
	23	Not Detectable	30 "

Complete hydriding is defined as saturated with H_2, e.g., 19,000 to 22,000 ppm.

TABLE II: HYDRIDING OF ZIRCALOY

Long Term Experiments (Hrs)

Temp.	H_2O Vapor Pressure mm Hg	Extent of Hydriding	Time
500 C	23	Complete	16 hrs.
700 C	23	Not detectable	2 "
	23	Complete	16 "
700 C (3-day 400 C autoclave film)	23	Complete	1 "

Etching Zircaloy. Installation and startup of the 314 Building horizontal etching prototype for PRTR experimental fuel components were completed during the month. The aluminum nitrate bath is circulated by means of a canned rotor type pump to help insure a uniform neutralization of hydrofluoric acid along the entire surface of the etched element. A similar circulation system for the etch tank using a Vanton pump is being tested.

The rinse tank in the new prototype has been equipped with spray heads to improve the rinse step by spraying the elements as they are being immersed in the hot water rinse and again as they are removed from the water. The sprays also keep the rinse bath well agitated, effectively aiding in the rinse.

Along with the experimental use of the etching prototype, above, several of the steps in the experimental fabrication of PRTR UO_2 fuel have been combined in 314 Building. These include: (1) cleaning, (2) light etch, (3) Zyglo testing for cracks, (4) heavy etch, and (5) autoclaving.

Structural Materials Development

Zircaloy-2 Process Tubes. Eighty-three Zircaloy-2 PRTR process tubes have met all specifications on inspection at the vendor's plant. Fifty tubes are at Hanford and the other 33 are yet to be shipped. There are an additional six tubes which have met all dimensional requirements; however, samples from five of these tubes exhibited slightly high weight gains during corrosion testing, and one tube has a high nitrogen content. The last nine tubes are currently undergoing final inspection.

Corrosion testing of samples from the PRTR tubes is being conducted by the Allegheny Ludlum Steel Corporation. Comparison test results on tube samples run at Hanford and at ALSC have revealed a bias of about 10 to 20 mg/dm^2 more weight gain during testing at ALSC. Since this difference could possibly result from variations in sample preparation or testing techniques, samples from the five tubes with high weight gains are to be retested at both Hanford and Allegheny Ludlum for a final determination of whether the tubes are acceptable. The specification for the PRTR tubes requires a weight gain of not more than 30 mg/dm^2; whereas the five in question exhibited weight gains of 32, 32, 33, 35, and 40 mg/dm^2 in the first tests by Allegheny Ludlum.

Coolant Systems Testing

Rupture Tests Out-of-Reactor. Two Zircaloy-2 clad solid aluminum core PRTR fuel element rods, one with a longitudinal slit defect and the other with a 1/32" hole defect were run in ELMO-7 Loop at 300 C in 9.0 pH water to determine whether the aluminum of a ruptured element would react excessively with the water. After operating periods of 2, 4, 8, and 16 hours, only a minor amount of swelling was noted on the slit-defected element and none on the hole-defected one. No increase in pressure drop was noted on either element during the test periods.

Component Testing. A total of 3500 thermal cycles between 230 F and 527 F have been made on a test section incorporating all the final top and bottom-end PRTR process tube seal designs. Small leaks were noted on the Flexitallic gasketed nozzle-tube connection during cooling cycles and continuously on the Flexitallic gasketed cap. All other joints were leak free. A Zircaloy-2 clad, solid aluminum core, simulated Pu-Al rod has been thermally cycled 1300 times between 250 F and 527 F to determine whether bowing will occur and whether the spiral mixing wires elongate.

The pressure drop of a 7-rod cluster element, consisting of the center 7-rods of a 19-rod PRTR element planned for KER testing, was measured at 2.03 psi at 60 gpm and room temperature, which calculated to an expected drop of 1.44 psi at 280 C bulk water temperature.

Radiometallurgy Laboratory Studies

Fission product gas collections were obtained from an eight-inch long UO_2 fuel element and from a Zr-2 clad four-rod cluster fuel element. Density measurements were made on 8 w/o Pu-Al, 8 w/o Pu-12% Si-Al alloy, and on uranium swelling program samples from KER-3-2. Vacuum annealing of the uranium specimens at 880 C reduced the density from 18.56 to 17.38 g/cc. The results and conclusions from this work will be reported in connection with the respective development programs of Ceramic Fuels, Plutonium Metallurgy and Physical Metallurgy Operations.

Thermal Hydraulics Studies

Air Cooling of PRTR Fuel Elements. Heat transfer experiments to evaluate the requirements for cooling the PRTR fuel elements by air in the fuel examination facility were completed. The data are currently being evaluated, and only preliminary results are available at this time. Two fuel designs were investigated: (1) Mark I 19-rod bundle, and (2) the outer ring of the Mark II-b concentric ring element. In each case a 36-inch long fuel element section was cooled by transverse air flow supplied by a prototypical baffle arrangement. The temperatures developed in the fuel sections were measured by thermocouple probes which could be placed inside the tubes and positioned at any desired location.

Four temperature points (90° spacing) were taken at four-inch intervals along the length of the Mark II-b while varying fuel element power, air flow rate, and tube rotation. Also, at two locations along the length of the tube, peripheral temperature transverses were made on a 10° interval.

Because of symmetry in the 19-rod bundle, only 13 of the 19 tubes were probed. Again, four temperatures at 90° spacings were taken at four-inch intervals along the length of each of the 13 tubes investigated. These temperature data were obtained for one power and flow rate. For three tubes in the bundle, power and flow rate were varied and the same temperature data obtained. Two of these tubes were selected because they had the highest temperatures in the bundle, while the third rod of moderate temperatures was selected as a low temperature reference.

Tentative results indicate that the temperature predictions made by Moulton in HW-57383 are very good. The highest temperature recorded for the Mark II-b at anticipated powers was 500 F, which is only about 20 F higher than the maximum predicted by Moulton. The high temperature location on the Mark II-b tube was always at the leading edge. Generally, the lowest temperatures occurred at the trailing edge. This effect is predicted by theory assuming that the ribs do not greatly affect the convection heat transfer. By changing the tube position, the change in heat transfer around the surface as a result of the ribs could be observed. This effect was small enough that treating the fuel element as a plain tube would be adequate for the planned application.

The maximum temperatures in the 19-rod bundle occurred in the tubes on the trailing edge of the bundle. For prototypical powers, the maximum temperatures noted were about 375 F. The clearance between the baffles and the wire wraps on the fuel rod was set at 1/8 inch. Moulton in his calculations assumed zero clearance between the wire wraps and the baffle and, as a result, obtained temperatures about 100 F less than determined experimentally. It was concluded that with these low temperatures little difficulty should be expected in cooling this fuel element.

The possibility of using a radiation thermocouple at the leading edge of the fuel element proved to be unsatisfactory with a plain shielded couple since the thermocouple temperature lagged the surface temperature about 300 F.

Heat Transfer Characteristics of PRTR Fuel Elements. Fabrication was completed of full scale electrically heated mockups of the Mark I and II fuel elements as well as a test section to explore boiling burnout under PRTR operating conditions. Installation of the subcooled burnout test section in the High Pressure Heat Transfer Apparatus was completed, and experimentation was initiated. Installation of the Mark II test section was started in another part of the apparatus for experimentation following work with the subcooled burnout test section.

Mechanical Equipment Development

Design Test PR-1 - Discharge Operation Mockup. Procedures and drawings of components required for testing the operational characteristics of the fueling vehicle were prepared. Two drawings for installation of the vehicle in the 314 Building were received from CE&UO for comments. Construction Engineering is preparing an estimate for installing the vehicle in the 314 Building.

Design Test PR-10 - Primary Loop Mockup. Construction of the Single Tube Prototype Mockup, Phase II, was completed. The PRTR primary process pump was operated at design conditions of 1050 psig suction pressure and 480 F on May 25. Heat-up was entirely by the pump and required about two hours of operation. Initial leakage from the mechanical seal was less than 0.01 gallon per hour.

Design Test PR-13 - Injection Pump Test. Pump No. 2 completed the test run of 537 hours operation and has been inspected. The bearing inserts show acceptable wear. The cylinders are grooved less than one mil, but perhaps deep enough to increase the wear on the chevron rubber packing, which was almost completely worn out. The leakage rate was about 1/2 gph at the end of the run for the three plungers combined.

Pump No. 1 has been returned to service using 440-C plungers and Hycar 1002 chevron rubber packing. The initial leak rate is about 100 ml/hr (1/20 gph). A five psi backpressure is being maintained on the leak collection header to simulate direct return of the water to the suction of the pump.

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Design Test PR-14 - Gimballed Bellows Joints. One 14-inch and one 8-inch gimballed bellows joints were ordered on April 29, 1959, from the Parts Engineering Company for testing before use in the PRTR primary piping. The 8-inch joint was cancelled since the joints are no longer to be used due to piping redesign. The 14-inch joint will be tested for future reactor application and for possible use in the PRTR piping should unforeseen piping stress problems require it later.

Design Test PR-20 - Calandria Characteristics. The Calandria Mockup was tested at pulsing frequencies of nine cycles per minute with no objectionable reaction. The pulsing mechanism is being altered to provide frequencies of 30, 60, 90, and 120 cycles per minute. Instrumentation to record the level variation is being provided.

Design Test PR-40 - Shim Control Mockup. The ball screw shim control, Prototype I, was operated for 210 cycles during May at 20 inches per minute for two rods and 13.4 inches per minute for the slave rod. The assembly is now being dis-assembled for inspection. Tests were run at rod speeds of 20, 30, 40, and 50 inches per minute with tolerable shaft whip. Prototype II is now being developed. It will provide main rod speeds of 32.5 or 51 inches per minute. Induction motors will replace the present hysteresis type to provide higher starting and stalling torques. The shim control ball bearings are being tested separately at 500 RPM in a 600 F saturated helium atmosphere.

Design Test PR-50 - Reactor Piping Seal Testing. The fully prototype process tube Assembly "C" completed 3500 thermocycles of 530 to 300 F at a pressure of 1350 psi with only negligible leakage on the nozzle cap seal and the nozzle to process tube seal. The final report on PR-50 is out for comment.

Design Test PR-51 - Reactor Piping Structural Integrity. Flexure cycling of the shortest outlet jumper was terminated after 53,000 flexure cycles at simulated reactor conditions of 530 F and 1270 psi. No adverse conditions developed during this testing period. The mockup is being modified to utilize a prototype nozzle assembly complete with gas seals. A new nozzle hold-down device to replace the existing tie-bars has been designed and is being fabricated. The final report on PR-51 is out for comment.

Zircaloy Tube Bursting. Two BDF Zircaloy process tubes were subjected to burst testing by localized over-heating. These tests resulted in complete failure, both longitudinally and circumferentially, under test conditions of 600 F and pressures of 2600 and 2700 psi.

Design Test PR-70 - Helium Compressor Test. The Hofer high pressure compressor and frame has been installed in the 314 Building. The Corblin low-pressure compressor is scheduled for delivery to the 314 Building May 28.

Inconel "X". A test piece of 3/8-inch ID, 20-mil wall, Inconel "X" with welded end connection was stress relieved and partially heat treated. It has been operated at 5000 psi and 1100 F for 126 hours. Six additional tubes are fully heat treated and will be tested with the use of compression fittings.

Gas Loop Jumpers. A 2-1/2 inch braided jumper with convoluted core has been delivered. A furnace is being prepared for testing the above jumper and the convoluted gimbal joint at 1500 F and 500 psi.

Reactor Technology Development

Reactor Safeguards. The analysis of possible loss-of-coolant incidents in the PRTR being conducted by Battelle Memorial Institute is essentially complete. It has been found that loss of coolant through a large rupture (14-inch equivalent diameter) of the primary coolant system should not result in fuel element melting if the water injection system functions as it is designed. Rupture of a process tube jumper, however, can produce a more serious situation in process tubes other than the failed tube. The fuel element temperature in an unfailed tube will rise to higher levels than in the case of a large rupture before injection water can adequately cool the element. Preliminary analysis indicates that injection water can prevent fuel element melting. The difficulty in cooling the fuel elements in unfailed tubes after a jumper rupture arises from the fact that all of the coolant flowing over the 84 fuel elements in unfailed tubes must escape through the rupture in one jumper.

A study of the PRTR safety circuit led to a recommendation to remove six trips from the safety circuit and to provide only annunciation for these abnormal conditions. The trips affected were:

1. Low level in Secondary Coolant Storage Tank
2. Failure of River Pumps
3. Low pressure Steam Generator Feedwater
4. Low level in Feedwater Deaerator
5. Low flow of Secondary Coolant
6. High pressure in Containment Building.

It was concluded that removal of these trips from the safety circuit would decrease the number of spurious scrams and would not compromise the safety of the reactor.

Process Tube Ruptures. The AECL installation at Chalk River was visited on May 21 and 22 to discuss test work performed at that site on process tube ruptures. The tests simulated tube failure at the expected operating pressure and temperature of the NPD-2 Reactor by mechanically weakening mocked-up steel process tubes. The eight successful tests indicated no damage to adjacent shroud and process tubes if the tube failure was of the plastic or ductile type as would probably occur by corrosion or wear mechanisms. In no case was the shroud tube surrounding the defected process tube extensively damaged. These results are directly pertinent to the PRTR since the shroud and process tube dimensions are practically identical for the two reactors.

Reactor Analogue Study. Suitable values for the UO_2 Doppler coefficient, heat capacity, and thermal conductivity (along with appropriate parameters for the nuclear kinetic equations) were selected and provided to members of the Instrument Research and Development Operation. These data will be

used in a study of possible nuclear accidents for inclusion in the final PRTR safeguards analysis report and for establishment of appropriate nuclear instrumentation scram trip points. It is expected that this study will be completed by August 1, 1959.

PRTR Physics Evaluation. Planning has been started for a series of neutron flux distribution calculations in support of the Plutonium Fuel Irradiation Test Program. It is planned to use the P-3 subroutine which has just been coded for the IBM-709.

The symbolic program deck and a writeup of the FORTRAN version of Carlson's SNG reactor code has been received from Argonne National Laboratory. Recompiling of this program on the IBM-709 is complicated by the fact that several input-output subroutines are coded in SAP language. Details of the program are now being studied to facilitate compiling.

Investigations to determine the self-shielding properties of plutonium fuels have been initiated. This has included the formulation of the problem and a suitable model for the basis of calculation. It is expected that a computer code will be written to solve general self-shielding problems employing monte-carlo methods of solution. Other calculational methods are being considered, however.

PRTR Instrumentation. Three resistance temperature detectors were received from Charles Engelhard Inc., as final design prototypes for PRTR. Calibration checks, bake tests, insulation checks and neutron irradiation tests have been completed. The resistance temperature detectors have responded satisfactorily. One of the three connector and cable assemblies supplied with the detectors failed at the connector at the end of a 90-hour bake test at 575 F. Insulation resistance of the cable and connector met specifications only after 90 hours at 575 F. Testing of connectors and cables is continuing.

Design Development

Phase I PRTR Construction Status. The Phase I PRTR contractor is 98.5% completed versus a scheduled 99.4%. The pressure and leak rate testing of the vessel was satisfactorily completed, and the inside of the vessel was turned over to the Phase III contractor on May 25, 1959. The major remaining uncompleted item is the painting, which was delayed due to the painters' strike. The contractor is scheduled to complete the remaining Phase I work on June 9; however, the effect of the painters' strike may change this date.

Phase II PRTR Construction Status. The Phase II contractor is 99% completed versus 100% scheduled. Acceptance testing on the water chillers and air compressors was completed. Acceptance testing and parallel operation testing of the process water pumps was delayed due to a cracked casing on the #1 process water pump.

Phase IIA PRTR Construction Status. The contractor is approximately 84% completed versus 100% scheduled. The contractor removed the dewatering pumps and evacuated the excavation on May 27, 1959, whereupon the rising Columbia River flooded the site. Essentially all concrete work is complete below elevation 350. The contractor is backfilling the excavation under water.

Testing of the 24-inch raw water line was attempted, but the temporary line supplied by the contractor was inadequate to hold the required test pressure.

Phase III PRTR Construction Status. The contractor is continuing to submit detailed approval information on equipment and fabricated items. The contractor started preparing interior containment vessel surfaces for the prime coat of chemical resistant paint on May 25, 1959. The walls of the cells are being prepared by acid etching. The floors at -32 and 0-0 levels and the ceiling at -5 level in the process cell are being prepared by sand blasting.

Process Piping. The primary coolant piping design was revised to provide expansion loops and eliminate the gimballed universal joints. The vertical thermal expansion stresses will be relieved by use of inclined planes to raise the steam generator as it expands away from the reactor.

Vendor drawings for the shield cooling system heat exchanger, HX-2, were received and approved with minor changes.

Core Components. The moderator storage tank has been received on site from the Consolidated Western Steel Division, U. S. Steel Corporation. The bottom shield gas seal, also furnished by Consolidated Western, is due to be shipped the early part of June. The first attempt to fabricate the gas seal was a failure, and the second has been completed except for dye penetrant inspection of the welds and dimensional inspection. When the bottom shield gas seal is received, all General Electric procured items which are necessary to allow the Phase III PRTR contractor to proceed with the installation of the reactor side biological shield will be on hand. The inlet ring header, the other item required, has been received.

Fabrication of the calandria and top and bottom primary shields is proceeding at a rate which indicates completion by the scheduled date.

Shielding. The side biological shield drawings were revised to include three eight-inch relief passages through the shield. These passages are sealed at the outer ends by rupture diaphragms. The purpose of the passages is to provide pressure relief from the reactor core should a process tube rupture. Two similar relief openings are being provided from the inside of the moderator vessel to allow pressure relief should rupture of a process tube also rupture the aluminum shroud tube.

A possible revision to allow the Phase III contractor to install a permanent steel outer shell on the side biological shield is being negotiated.

Instrumentation and Control. The PRTR fuel element rupture detection system design criteria was approved. Detailed design of the mechanical part of the system, including piping, shielding, supports, etc., will be performed on site. The detailed design and construction of the instrumentation components is expected to be accomplished off-site on a fixed price basis.

The Minneapolis-Honeywell strike, which began on March 12, ended on May 19. The delivery of the PRTR automatic controller and neutron sensing instrumentation is expected to be delayed about two months beyond the original delivery date of June 30, 1959.

Design Analysis. Several firms have expressed interest in performing piping stress analyses for the PRTR primary cooling system. A formal request for proposals is being prepared. A study of helium evolution during cooling of the PRTR primary coolant has been extended to include other considerations which could interfere with convection cooling of the reactor during a total power outage. A letter is being prepared recommending revisions and procedures which would minimize the possibility of loss of convection cooling.

A computing program is being prepared for calculation of flow, temperature, and pressure transients in the PRTR primary cooling system following failure of various devices and components. The primary goal of this study is to determine whether or not additional system overpressure protection is desirable and, if so, what the size and response time of the protection mechanism should be.

Supercritical Pressure Steam Loop. A final draft of a report describing a supercritical pressure power reactor conceptual design has been completed and is being prepared for publication. The scope description (HW-60506) for the supercritical pressure steam loop was revised and completed. This scope is based on testing fuel elements representative of a power reactor having three-pass cooling with turbine inlet conditions of about 3250 psi and 1050 F. Further analysis will determine the adaptability of the loop for superheated steam at exit conditions of about 2400 psi and 1050 F. Preliminary sizing of loop equipment has begun.

Information collected on Inconel-X and possible alternate materials for fuel element manifolds and connecting piping indicates that difficulty may be encountered in fabrication of the intricate coolant passages in the fuel element assembly. Design data are very limited, especially for appreciable service life. The available information and advice are being summarized as the basis for a development program in support of the supercritical pressure steam loop and the high pressure gas loop.

Process Tube Assembly. Minor revisions to the outlet nozzle design were made to improve seal details and allow for redesign of the hold-downs.

Fuel Element Examination Facility. The Phase I contractor has completed replacing the walls of the pit for the purpose of bringing them within dimensional specifications. The critical dimensions are being checked to determine that this has been accomplished.

The W. F. & John Barnes Company has approved the contract for the Primary Manipulator and has started the detailed design.

Tests completed by the Thermal Hydraulics Operation have substantiated the heat transfer calculations used to determine the fuel element cooling requirements. However, attempts to measure fuel element temperature with non-contact probes were not successful. Further development work on the problem has been planned.

The detailed design of the control console for the fuel examination facility has been started. The two outside sections, which contain the viewer and services controls, will be procured by GE while the center section, containing the manipulator controls, will be provided by the manipulator manufacturer.

Plutonium Fabrication Pilot Plant

Phase II Construction. Completion of work under Phase II is estimated at 99%. Work was scheduled to be complete May 11, including the extension of time granted to Hoffman by HOO-AEC. Items of work remaining to be completed are mostly electrical and painting.

A design change, substituting vinyl-asbestos tile for chemical resistant coating in the low level and service corridors, has been submitted in order to expedite completion of the job and minimize interference with the Phase III contractor. Acceptance testing of the ventilation control system and the fire alarm system is in progress.

Phase III Construction. Completion of work under the Phase III contract is estimated at 36%, as scheduled. The contractor's schedule, which shows actual completion of most items of equipment late in the schedule, has been approved by HOO-AEC.

A design change, substituting vinyl time for chemical-resistant coating in the main floor corridor, has been submitted to expedite the completion of the Phase III contract.

Procurement. All project procurement is essentially on schedule with the exception of hoods for the sintering furnaces, design of which is still incomplete, and the hooded extrusion press, being delayed at the request of Purchasing until controversy over an earlier extrusion press order is settled. Present plans are to have the sintering furnace hoods fabricated by Minor Construction.

PRTR Operations

Pre-Startup Activities. These activities during the month have included preparation of a training program schedule for PRTR engineering assistants, preparation of detailed outlines for a number of the training lectures, completion of a process sampling program for the reactor operation, and discussion of reactor operating data processing plans with interested research and development groups. In addition, a study of each component of the PRTR is under way to anticipate the areas where high level radiation fields may be encountered during reactor operation and maintenance activities. These analyses will provide the bases for special operating and maintenance procedures and, where appropriate, for additional shielding or other minor equipment changes.

Design information reviewed during the month included the design of the shim rods, Panellit prints for the control room and for C cell instrumentation, and design data for the PRTR automatic controller. Review of Phase III contractor's procurement drawings continued.

Construction and Procurement Liaison. A report was issued which describes the testing of the low and high pressure helium compressors. The low pressure unit was found to be satisfactory; however, the high pressure unit lacks reserve capacity and will require a change in the drive.

The process water pumps, installed at the -12 foot level of the PRTR Service Building, were tested by the manufacturer. The tests, witnessed by PRTRO personnel, indicate that "hunting" of the pumps probably will not be a problem. The tests were discontinued when the lower casing of one pump cracked but will be resumed after the pump is repaired.

The diesel engines which drive the emergency generator and the deep well pump, respectively, were prepared for acceptance testing. As a result of work to date, a modified fuel feed system has been recommended.

Assistance was rendered to CE&UO during the preparation and performance of the containment vessel pressure and leak rate test. Analysis of the data continues.

2. BASIC SWELLING STUDIES

Irradiation Program

An evaluation was made of thermocouples and heating elements received for the swelling behavior capsule. All of the heating elements and half of the thermocouples were radiographed for internal defects. Four of the heating elements displayed marked displacement at the joint of the internal lead wire and the heating wire. These heaters will not be used in capsule construction. Time, temperature, and power curves were run on two representative heaters. The tests show that the heaters are capable of handling only one-third the power required by the capsule at maximum operating temperature (800 C). The heaters were also slow in response (the magnesia insulation acts as a thermal barrier for rapid transfer of heat) and fail

to meet the requirements of the capsule for maintaining a steady temperature in a rapidly changing flux field such as experienced at reactor shutdown. A capsule design must be developed to properly utilize the heaters as they are; new heaters must be designed for the higher temperatures and rapid response time requirements. The thermocouples showed no obvious defects; however, a very marked increase in indicated temperature was observed on both couples at around 303 C (577 F), which is the temperature of the formation of the volatile oxide of the tantalum tips.

An instrumented capsule has been designed for the irradiation of metallographic specimens in the ETR. Constant temperature of the specimens will be maintained by augmenting gamma and fission heating with electrical heating. Two thermocouples are provided to monitor the temperature of the uranium specimen and the NaK adjacent to the specimen. The capsule design is such that unrestrained swelling can proceed to a 50 percent increase in volume.

Two capsules from a total of six, GEH-14, 33 through 38, have been discharged from the MTR. Each capsule contains a uranium pellet, one-half inch in diameter by one-quarter inch high, which has been carefully characterized as to microstructure, microhardness, x-ray diffraction line breadth, density, and geometry. The purpose of the irradiation is to determine the effect of flux intensity, burnup, and temperature of irradiation on the swelling and associated structural changes in unrestrained uranium. Post-irradiation examination of the irradiated specimens will begin in July.

Simulated Swelling Experiments. An apparatus designed to cause simulated swelling by the introduction of inert gas with an electrical glow discharge is being fabricated. The metal system is almost complete and the glass system for evacuation and gas introduction is being designed. The apparatus will be used to prepare uranium for studies to determine correlations between pore sizes and gross dimensional changes, as well as investigations of the mechanical properties at elevated temperatures of uranium containing inert gas pores.

Uranium foil was subjected to a glow discharge in xenon at 850 C (1562 F). No change of the uranium density was detected. However, the efficiency of gas deposition may have been low due to incorrect experimental conditions.

Mechanisms and Theory.

Diffusion of rare gas fission products through uranium may be important in both the rate of formation and the rate of gas pressure increase in pores. Mobilities of these gases in uranium are, therefore, being investigated. In the present studies, rare gases are introduced into the uranium surface by means of electrical glow discharge (sputtering). Introduction of rare gases into uranium by sputtering may be a highly surface dependent phenomenon. Therefore, interactions of rare gases and uranium surfaces are now being studied. The uranium has been sputtered with helium at current densities of approximately 0.004 amp/cm^2 for times of 27 minutes to 64 hours. Upon heating the uranium in vacuum, large quantities of helium were evolved from the surface. The amount of helium evolved at a given temperature appeared

to be dependent on the length of sputtering treatment prior to heating. A uranium surface was placed in contact with a helium atmosphere for 16 hours without sputtering. No detectable amount of helium was evolved from the surface during subsequent heating.

Optical and electron microscopy are being used as a direct means for detecting the size and distribution of pores in uranium. The investigation of the possible distortion of pores arising during the specimen preparation (polishing, etching, and replication) is continuing. A rod specimen of uranium, which had been irradiated to a burnup of 0.25 a/o at a maximum core temperature of 450 C (842 F) has been annealed for 100 hours at 880 C (1616 F). After irradiation, the density of the rod specimen clad with 0.030 inch of Zircaloy-2 had decreased 1.6 percent. Annealing of the specimen after removing the cladding caused the density to decrease 6.4 percent for a total density change of 7.8 percent. Attempts at correlating the density changes in the uranium with the density changes calculated from a statistical analysis of the microscopic pores in the uranium are currently in progress.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

PRTR Pressurized Gas-Cooled Loop Facility (CAH-822). Revision 1 of the Gas Loop Project Proposal has been approved, increasing the estimated cost of the project to $995,000. The revision increases maximum temperature of the loop from 1100 F to 1500 F. Bids for the gas-lubricated primary blowers have been received and are now being evaluated. Apparent low bidder is Bristol-Siddeley of England, with a bid of about $45,000.

The bid opening date for the main design-and-fabrication contract for gas loop equipment has been set at June 15. Because of the complexity of the job and the interest shown by bidders, a pre-bid conference has been scheduled for June 4.

A program is being formulated for investigation of "super-alloy" type metals to determine the most suitable alloys for use in high temperature portions of the loop for both in-reactor and ex-reactor portions. Because of a community of interest, this effort is being undertaken on joint behalf of the gas loop and the supercritical pressure loop.

In-Reactor Capsule Tests. The first in-reactor test to help establish the range of variables for the gas loop tests was charged into KE Reactor. This consisted of four quartz capsules containing graphite in carbon dioxide at 200, 300, 400, and 500 psi at 500 C. Prior to insertion the samples were degassed, weighed, and measurements of surface area and dimensions were determined. Following irradiation at 500 to 600 C for six to eight months, the gas composition and changes in properties of the graphite will be determined. These tests will provide information on: (1) the in-reactor equilibrium gas concentrations of the reaction, $CO_2 + C = 2CO$, and (2) the effect of pressure on the reaction rate.

Coated and Impermeable Graphites. In coating graphites, special base materials are normally required to attain crack-free surfaces. A high purity, reactor grade graphite, TSGBF, coated with silicon carbide by Carborundum Company has recently performed satisfactorily in oxidation tests, losing no weight in 113 hours at 1000 C in air.

About thirty coated samples, some of which satisfactorily passed pre-irradiation oxidation tests have been charged into KE Reactor. The effects of high temperature reactor irradiation will be determined on permeability, oxidation resistance, and other properties as described in HW-60397, "Investigation of Carbide Coated Graphites for Reactor Applications."

Microwave Glow Discharge Studies. Attempts to establish a glow discharge in a quartz system for the production of active gas molecules in gas-graphite studies were unsuccessful until repeated cleaning of the quartz surfaces with hydrofluoric acid was carried out. The system was flamed out during assembly to remove water vapor. In air at about 10^{-3} mm Hg a glow was initiated with a Tesla coil and maintained by microwave glow discharge. The discharge zone narrows with increasing pressure and is finally extinguished before atmospheric pressure is reached. At low pressures the discharge can be maintained at a power as low as 50 watts at 2450 megacycles. Raytheon directors of type A and type C were used successfully. The type A (round reflector) gives a larger, cooler discharge than type C (corner reflector dipole) but appears quantitatively to produce about the same number of oxygen atoms. In air, the characteristic red glow of oxygen is seen in the discharge, the greenish-white "afterflow" is found downstream, indicating the presence of oxygen atoms by the reaction $NO + O \longrightarrow NO_2 + h\nu$. In CO_2, the discharge is blue-white, and once again the afterglow is greenish-white. For the gas-graphite studies the number of oxygen atoms formed will be determined quantitatively by "titration" in the gas phase with NO_2.

Gamma Irradiation Facility. Construction of the cobalt-60 irradiation facility for studies of gamma radiation effects on the rate of reaction of various gases with graphite is continuing. A 7-foot diameter stainless steel tank was placed on a 20-inch concrete base located 13 feet below floor level in the Graphite Laboratories of 3730 Building. After erection of the restraining wall, the tank will be filled with water in preparation for receipt of the cobalt-60. Construction is scheduled for completion by July 1.

Fabrication of the underwater assembly to hold the cobalt in the desired configuration was started. Gamma irradiations will be performed in four 2-inch diameter tubes extending from above the water down to the vicinity of the cobalt rods.

The source will be calibrated by chemical dosimeters using ferrous and ceric sulfates. An aqueous solution of ferrous ions is oxidized to ferric ions when subjected to ionizing radiation. Ionization chambers will also be used to measure dose rates at various distances from the source. After calibration of the facility is completed, graphite oxidation experiments will begin.

D. CUSTOMER WORK

Radiometallurgical Examinations

Hot Pressed Uranium Wafer Element, PT-IP-134-A (RM-245). A 1.8-inch OD, A-2 aluminum alloy jacketed, hot press canned, 1.6% enriched, wafered uranium I & E fuel element was irradiated to low exposure at high power.

During the month a second cross-sectioned wafer was examined metallographically. There was no sign of any defect in the nickel coating which would indicate aluminum-uranium diffusion which might have resulted from the canning technique. The nickel bonding, or coating layer, exhibited three fairly well defined "compound zones". The zones nearest the uranium and the aluminum can wall are about 1/8 the thickness of the total nickel layer. It is not known at this time whether such "zones" were present prior to irradiation.

RM-298 - Examination of M-388 Failure 2765B, and RM-299 - Examination of M-388 Failure 5148 KE. Examination of the ruptured fuel elements from Tube 2765B and 5148 KE showed that they had failed in the inner spire. The rupture from Tube 2765B was 3/8" from the male end, compared with a position 1-7/8" from the male end in the 5148 KE fuel element. A technique employing a red penetrating dye was used to verify the point of water entry. In both cases it was definitely shown that the water entered at the male weld through cracks or pin holes associated with or near the terminal weld crater. A piece of the outer can wall was removed from the fuel element from 5148 KE to determine whether any corrosion occurred at a questionable spot on the side of the element. This portion of the examination has not been completed.

Examination of X-8001 Clad I & E Fuel Element from Tube 2762D (RM-303). An inspection of discharged fuel elements from Tube 2762D revealed that several fuel elements had been severely corroded. One selected fuel element, clad with X-8001 aluminum alloy, was received for detailed examination. Erosion-corrosion effects were observed over 90° of the fuel element circumference along the topside of the fuel element. Microscopic examination is now in progress on a cross section of the fuel element which showed that corrosion had penetrated through the can wall through the AlSi and into, but not through, the compound layer.

Examination of Warped and Unwarped OIIN Natural Uranium Fuel Elements From 105-H (RM-296). The warped, bumpy fuel element exhibited a maximum warp of 0.625 inch located 3-1/2 inches from the base end. Both fuel elements were photographed in the as-received condition. A metallography sample taken from the maximum warped area was polished and electrochemically etched. The photomicrographs reveal a larger than normal grain structure.

Metallography Laboratories

An attempt to identify the most brittle of the layers formed between uranium and AlSi is now being made. Selected cuts from two slugs, which proved later to be almost ideally brittle, were mounted as metallographic samples. These two samples were polished in a plane tangential to the outside surface of the uranium. This technique resulted in an exposed layer of the brittle material

which was mechanically magnified between 20 and 50 times. It was hoped this would provide a sample or samples which had sufficiently large areas of the brittle compound exposed for x-ray analysis by back-reflection techniques. These two samples have been submitted for x-ray study.

A Wilson Tukon Hardness Tester (microhardness tester) has been placed in service in the 306 Building Laboratory. This unit has been tested and checked against a similar one in the 326 Building Laboratory. The two units were found to check closer than the normal scatter of hardness values, and the new unit is now ready for service. A second bench microscope has also been obtained and placed in service in the 306 Building Laboratory to relieve a bottleneck in the microscopic examination of samples.

Samples Processed During the Month

Total samples Processed: 200

Photographs

Micrographs	440
Macrographs	47
Total	487

F.W. Albaugh

Manager, Reactor and Fuels Research
and Development

FW Albaugh:kb

DECLASSIFIED [redacted]

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
FW Albaugh	5/13-14	ANL, Lemont, Ill.	Dedication Services & discuss plutonium fuels	FG Foote N Hilberry	No
HK Nelson	5/1	duPont Company, Aiken, S.C.	Discuss rupture monitor problems.	L Cathey	Yes
DP Schively HJ Pessl	5/18-19	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Discuss high temperature alloys.	S Bartz E Thurston	Yes
WK Winegardner	5/20	Willammette Iron & Steel, Portland, Ore.	Fabrication of PRTR fueling vehicle.	O Novak F Dever	No
DE Rasmussen	5/25-28	Philadelphia, Pa.	ASME meeting.	--	No
RE Peterson PC Walkup	5/21-22	AEC of Canada, Ltd.; Canadian GE; Chalk River, Ont.	Discuss reactor physics and safeguards.	T Burnup DLF Bates E Critoph et al	Yes
H Harty	5/12	Amer.Soc. of Heat. & Vent. Eng., Seattle, Wn.	Present talk on PRTR.	H Hendrickson	No
RM Fryar	5/13-15	AEC-IOO, Idaho Falls, Ida.	Attend Test Reactor Meeting for Industry.	FK Pittman	No
HE Hanthorn	5/6-11	Salem Fabrication Co., Salem, O.	Confer on sintering furnaces to improve shipping date.	Mr. Zimmerman	No
MR Kreiter	5/19-28	Consolidated Western Steel, Los Angeles, Calif.	Follow progress of fabrication of PRTR calandria & shields.	DJ Bentley	No
KR Merckx	5/1	ASME, Metals Div. Mtg., Albany, N.Y.	Present paper.	--	No
SH Bush	5/1-30	USAEC, Washington, D.C.	Reactor Dev. Fuels Task Force.	FK Pittman	Yes

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
EA Evans	5/1	BMI, Columbus, O.	Discuss fundamental studies of UO_2.	FR Shober	Yes
	5/2	Numec Co., Apollo, Pa.	Same as above.	Mr. Shapiro	No
	5/4	US-AEC, Washington, D.C.	Arrange for June Meeting at Harwell, England, for exchange of UO_2 info.	JM Simmons	Yes
		Same as above.	Discuss studies of UO_2.	Mr. Handwerk	Yes
WC Roberts JH Johnson	5/1 5/1-15	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Inspect Hanford facilities.	R Neidner	Yes
FB Quinlan	5/1	Blaser Tool & Mold Co., Seattle, Wn.	Locate shops to take overflow work.	FM Blaser	No
		Ravenna Metal Prod., Seattle, Wn.		JD Gibler	No
		Sulak Mfg. Co., Inc., Seattle, Wn.		AF Sulak	No
LE Mills	5/4-5	Precision Welder & Flexopress Co., Cincinnati, O.	Observe & evaluate magnetic head welding machine.	A Schueler	No
RJ Anicetti	5/5	Fiberglass Eng'g., Seattle, Wn.	Discuss & inspect several sound absorbing barriers.	Mr. Powell	No
	5/6	Pacific Sound Control, Seattle, Wn.		Mr. McGuire	No
		Sound Control, Seattle, Wn.		Mr. Bradley	No
TK Bierlein	5/6	U. of Washington, Seattle, Wn.	Discuss cirriculum for graduate chemistry course at UW Center at Richland.	EC Lingsfelter	No
B Mastel	5/6	Wash. State College, Pullman, Wn.	Present talk on electron microscopy.	C Stevens	No
WL Wyman	5/11	Iron Fireman Co. & Kinkade Tool & Mach.Wks., Portland, Ore.	Inspect tools & jigs.	Mr. Louey Mr. Kinkade	No

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VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
DC Kaulitz	5/6	Convair-Dynapak Div., Los Angeles, Calif.	View acceptance tests on Kynapak.	J Ottestad	No
		Sprawl Eng'g. Co., Bell Gard, Calif.	Review gas system for rupture tests.	Mr. Sprawl	No
	5/7	Res. Welding & Eng'g., Compton, Calif.	Discuss contract.	G Garfield	No
	5/11-15	AEC-IOO & Phillips Pet.Co., Idaho Falls, Ida.	Test Reactor Meeting for Industry.	R Neidner	Yes
JL Bates MK Millhollen FE Young	5/12-15	Same as above.	Consultation GEH-12; to reinstrument & recharge GEH-10-5.	R Neddner	Yes
FB Quinlan	5/15	Wilson & Sprou; Aluminum Supply Co.; Vitco Co.; Spokane, Wn.	Locate shops to take overflow work.	Mr. Wilson CT Dishman RJ Stanford	No " "
RJ Anicetti	5/17	GE, Pittsfield Chem. & Metal. Div., Chicago, Ill.	Conference on fusion of UO_2.	R Dillon	No
	5/18	Chicago, Ill.	Attend ACS meeting.	--	No
	5/19-20	ANL, Lemont, Ill.	Discuss plutonium & ceramic fab. facilities at ANL.	JF Schumar	Yes
JE Minor	5/19-20	USAEC, Washington, D.C.	Discuss experimental irradiations of ETR & MTR	JM Simmons I Zartmann	Yes
	5/20	ANP & KAPL personnel mtg., Chicago, Ill.	Same as above.	--	No
JP Pilger	5/20-22	Cincinnati Milling & Grinding Machine Inc., Cincinnati, O.	Observe & evaluate spark machining of Zircaloy spiders.	J Gross	No
EA Evans	5/21-22	USAEC, Washington, D.C.	Review of HLO UO_2 work for AEC Fuels Task Force.	MJ Whitman	Yes
	5/23	Armour Research Found., Chicago, Ill.	Discuss UO_2 fabrication process.	Mr. Rosenblum	No

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VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JC Tverberg	5/20-23	Magnethermic Corp., Youngstown, O.	Induction heat treating of uranium rods.	N Ross	No
	5/25-29	BMI, Columbus, O.	Observe high pressure bonding.	FR Shober	Yes
	5/27	Ohio Crankshaft Co., Columbus, O.	Induction heat treating of uranium rods.	HB Osborn, Jr.	No
RS Kemper	5/21	Oregon Metallurgical, Albany, Ore.	Institute work on DDR-61.	W Ashoff	No
RE Olson	5/25-27	Alcoa Res. Lab., Cleveland, O.	Possible manufacturers of end fittings for PRTR fuel elements.	--	No
		Cliff Mfg. Co., Cleveland, O.		CH Wright	No
	5/28	GE - Quality Control, New York, N.Y.	Consult on quality control functions in Ceramic Fuels.	AV Feigenbaum	No
	5/29	Kux Machine Co., Chicago, Ill.	Discuss problems re Kux press.	J Kux	No
JW Riches	5/20	Allegheny Ludlum Steel, Watervliet, N.Y.	Consult on Zr fabrication development.	TG Magle	No
	5/21	Mallory Sharon Niles, O.		FA Heinselman	No
	5/22	Carborundum Metals, Akron, N.Y.		HA Andersen	No
JM Davidson	5/18-21	GE - Hotpoint Div., Chicago, Ill.	Attend MTR-ETR Users Mtg.	TJE Glasson-KAPL J Provost-ANP	No
RE Falkoski	5/4-10	Offett Field, Omaha, Neb.	Inspect equipment.	--	No
		LASL, Los Alamos, N.M.	Attend symposium.	W McNeese	Yes
TD Chikalla	5/15-22	Chicago, Ill.	Attend Amer.Ceramic Soc. Mtg.	--	No
SH Woodcock	5/25-27	Philadelphia, Pa.	Attend ASME Conference.	--	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
ID Thomas	5/18-22	USAEC, Washington, D.C.	Civilian Reactors Fuel Element Advisory Group	CRFEA Group	No
		GE, Schenectady, N.Y.		DW Lillie	Yes

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
MC Beekman HA Wagner REL Stanford PJ Robinson FJ Leitz	5/18-19	Detroit-Edison Co., Detroit, Mich. GE - Detroit, Mich. GE-APED, San Jose, Calif.	Discuss fuels development work.	FW Albaugh et al LH McEwen et al LP Bupp et al	No	300, 325,326,327, 3760, 328 200W, 231-Z
S Glassman	5/5-6	Nuclear Dev. Assoc., White Plains, N.Y.	Discuss PRTR design.	H Harty LT Pedersen	No	700, 760 300, 314
AW Lemmon	5/25	BMI, Columbus, O.	R&D contract.	TW Ambrose NG Wittenbrock	No	700, 760
G White DR Shoults	5/18	APED, San Jose, ANP, Cincinnati	Discuss PRTR.	RM Fryar	No	PRTR Site, 300, 328
A Bournia	5/14	WAPD, Bettis Field, Pittsburgh, Pa.	Discuss two-phase flow techniques.	JM Batch	No	100D, 1707, 189
D Jones O Olson W Morgan	5/21	ORNL, Oak Ridge	Discuss Pu fuel element fab. facilities.	LG Merker HE Hanthorn	No	PRTR Site
JC Kyle WO Laande H Potter	5/7	Tech. Industries, Pasadena, Calif.	Discuss details & transducer design & characteristics on in-reactor creep capsule.	JJ Cadwell JC Tobin LJ Chockie	No	300, 326

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
A Zeitlin	5/7-8	Eng'g. Supervision, New York, N.Y.	Discuss high pressure vessel & closure design.	JJ Cadwell et al	No	300, 326
HF Beeghly	5/11	Jones & Laughlin Steel Corp., Pittsburgh, Pa.	Discuss iron base alloy for fuel element jackets.	JJ Cadwell et al HJ Pessl	No	300, 326
WD Manly	5/11	ORNL, Oak Ridge	Discuss fuel element tech.	JJ Cadwell	Yes	300, 326
MJ Welther	5/13-14	Sciaky Bros., Inc., Los Angeles, Calif.	Consult on proposed contract.	LE Mills	No	300, 325
EW Baker BB Hedrick	5/25-29	Convair Equip. Div., Pomona, Calif.	Supervise installation of a Dynapak machine.	DC Kaulitz	No	300, 326
DT Jones WL Morgan AR Olsen	5/18-19	ORNL, Oak Ridge	Discuss facilities for alpha-beta-gamma hot labs; irrad. Pu samples.	LD Turner OJ Wick	Yes No	300, 327, 325, PFPP 200W, 231Z
JT Waber	5/15	LASL, Los Alamos	Attend Corrosion Symposium and discuss problems.	C Groot RL Dillon	No	300, 326, 325
EL Compere	"	ORNL		RL Dillon	"	300, 325
ES Snavely	"	"				
M Simnad	"	Gen.Atomics, San Diego		"	"	"
WE Ruther	"	ANL, Lemont, Ill.		"	"	"
NR Grant	"	"		"	"	"
JR Weeks	"	BNL, Upton, N.Y.		"	"	"
CJ Klamut	"	"		"	"	"
			Discuss high temp. corrosion	JA Ayres	Yes	100-KE, 1704, 1706,105
JM Wright GP Simon	5/15	WAPD, Bettis, Pittsburgh, Pa.	Discuss decontamination.	JA Ayres	Yes	" "
EC Hoxie	"	SRL, duPont, Aiken, S.C.	Discuss corrosion equip.	"	Yes	"
WL Pearl	"	APED, Vallecitos	"	"	Yes	"

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VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
H Pennington	5/22	USAEC, Tokyo, Japan	Discuss Japanese graphite irradiations & gas loop.	RE Nightingale WA Snyder FW Woodfield FW Albaugh	Yes	300, 326, 328
JH Rubin	5/18	SROO, Augusta, Ga.	Discuss PRP & high burnup Pu requirements.	FW Woodfield	Yes	300, 328
H Erying	5/7	U. of Utah, Salt Lake City	Consultant Agreement CA-206.	FW Woodfield et al	No	300, 3760
JV Cathcart EE Hoffman DH Jansen WF Toner	5/14	ORNL, Oak Ridge	Attend Corrosion Symposium & discuss problems.	RE Nightingale RA Thiede	Yes	300, 326, 314
W Alter V Schnizlein	5/8 5/13	GE, Vallecitos ANL, Lemont	Discuss Pu-Al alloy program. "	RW Stewart "	No "	200W, 2704Z, 231Z "
LV Jones	5/14	Mound Lab., Miamisburg, O.	Discuss program of special Pu operations.	OJ Wick	No	"
Dr. Shepherd	5/14	Stanford U., Palo Alto, Calif.	Discuss transformation kinetics	OJ Wick RD Nelson	No	200W, 2704Z
P Bonnell V Storbok	5/14 5/18	BMI, Columbus, O. "	Observe hood operations re Pu R&D.	RW Stewart	No	200W, 2704Z
JH Rubin	5/18	SROO, Augusta, Ga.	Discuss Trans-Pu program.	RW Stewart	No	200W, 2704Z
J Jepson P Naillon WJ Ramsey M Harris D Lord	5/19-22	LRL, Livermore, Calif.	Discuss '60 R&D program & device fab. in '60.	OJ Wick RW Stewart	Yes	200W, 2704Z, 231Z

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

MAY 1959

FISSIONABLE MATERIALS - 2000 PROGRAM

FUELS

Nuclear Safety in the Fuels Preparation Department

A study was made on the nuclear safety in the manufacture, storage, and shipment of 1.6 percent U-235 enriched fuel elements from billets. The variables investigated were described in the April Monthly Report (HW-60233B). The results of this study are being transmitted to FFD in document HW-60509, "Coextrusion of Enriched Uranium (Nuclear Safety)" by P. F. Gast.

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Lattice Neutron Temperature Study

A report describing the recently completed study is being prepared for publication.

Thermal Neutron Flux Spectrum Near a Temperature Discontinuity

A. Theory

The IBM 709 FORTRAN program to obtain numerical results for this problem has been debugged and checked on a number of cases. A report to describe this program is now being written.

An analytical investigation was begun on the slightly more general problem of the perturbing effects on the neutron flux spectrum due to a net neutron flow across a plane temperature interface. Results obtained so far show that analytical and numerical methods previously used in the case of zero net current are applicable in this case also.

B. Experiment

In order to establish the reliability of the results of these analyses, tests of the applicability of the plane diffusion model used in the analyses are considered to be necessary. Two tests are possible. The first has been made and has yielded a negative result. The second test is in progress at present and no indication of the result is available.

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Instrumentation

The stack effluent gas monitor, used for investigation of stack gas gamma energies, was moved from the 100-D to the 100-F stack house. Problems because of line voltage transients were thus eliminated and, since the 100-F stack house is several times larger than the 100-D stack house, the temperature problems should be alleviated. The gamma energy spectrum at 100-F was determined to be similar to that at 100-D. None of the spectrum analyses data, to date, have shown any clearly discernible peaks. At present, the system is set to count the 364 Kev I^{131} photopeak. A slug rupture should give some valuable data concerning the magnitude increase of I^{131} during this condition.

The two-color pyrometer ordered from Shaw Instrument Company was received. The most suitable target available to test it on was a tungsten ribbon filament lamp. An auxiliary lens was used to magnify the filament sufficiently to fill the aperture of the Shawmeter. The instrument performed well. Attempts were made to extend the range of the instrument to include both lower and higher temperatures. As received, the Shawmeter covers the range 1000°C to 2500°C. The use of a Corning 3486 filter permits extending the temperature range to at least 3000°C and probably much higher. Attempts to extend the range to temperatures below 1000°C have thus far been unsuccessful although it seems likely that this can be accomplished.

The core readout register drive and inhibit drives for the simple computer have been installed on a separate chassis along with the readout register. This unit is undergoing tests to determine its effectiveness and work is beginning on output logic and display.

Consultation was given to the Instrument Design Operation concerning a six-point recorded six-scintillation head remote area scintillation gamma monitoring system. It will be used at Arco, Idaho. It is to be a linear decaded system useful from 10 mr/hr up to 100 r/hr. The system is basically that developed and tested by us and reported in HW-59834.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Lattice Measurements for Large Diameter Fuel Elements

The series of material buckling measurements on lattices using 2.5-inch solid fuel elements has been completed this month. The one lattice whose final buckling has not been reported is given below.

Lattice Spacing	Buckling (10^{-6} cm^{-2})	Side to Side λ (Inches)	Volume Ratios Al/U	H_2O/U	C/U
14 9/16 dry	+ 98	1.39	0.185	--	41.58

The extrapolation length is denoted by λ. The front-to-rear λ used was 1.03 inches. The buckling reported forthis lattice is an average of two independent measurements. These two measurements were taken to determine the reproducibility in buckling measurements. The results were:

Buckling (10^{-6} cm^{-2})	ΔB^2
100	± 2
96	± 1

The ΔB^2 is a standard deviation derived from a "goodness of fit" of the data and does not include uncertainties in the extrapolation length.

The following material bucklings for 1.92-inch solid and 2.5-inch tube and tube fuel elements have been measured this month:

Fuel Element	Lattice Spacing	Buckling (10^{-6} cm^{-2})	Al/U	H_2O/U	C/U
1.92	12 3/8 wet	+ 40	0.264	0.288	51.31
1.92	10 3/8 wet	+ 68	0.264	0.288	35.60
2.5 x 2.0 with 1.66 x 1.1	14 9/16 wet	-120	0.487	1.089	68.48

These buckling values are tentative using an estimated side extrapolation length of 1.66 inches and a front-to-rear extrapolation length of 1.03 inches. Final bucklings will be reported after completing the analysis of horizontal traverses.

The delay in analyzing the horizontal traverses is due mainly to the large number of hand calculations required to prepare the data for the IBM-709. A complete horizontal traverse program is now being written. This program, when completed, should reduce the hand calculations now required by at least a factor of two.

A high value of λ for the 2.5-inch element in the 12 3/8-inch lattice reported last month prompted a closer look at the methods of taking horizontal traverses. There is a possibility that traverses taken at different points in the cell may give different measured values of λ. Traverses have sometimes been taken in tube rows halfway between the tubes and sometimes in filler layers halfway between the tubes or at the corners of each cell. This technique provides only one point for each process tube, which is not as many data points as might be desired for a good fit to the cosine horizontal flux variation. To double the number of points available, one of the traverses with 1.92-inch elements was taken at points displaced to either side of the line connecting fuel elements, so that two points per tube could be measured without fine structure corrections. Then the work of Selengut on heterogeneous diffusion coefficients indicated that the best place to take the traverse is at the points on the cell edge where the flux is the same as the flux at the edge of the equivalent cylindrical cell. This work also indicated the possibility of horizontal streaming in the filler layers if the lattice spacing is large enough for neutrons to diffuse out of the pile without interacting with the fuel. These considerations have led to a study of λ taken at several positions in the cell which is now in progress. Several different traverses will be taken in the same pile to eliminate effects of other variables.

PCTR Measurements of k_{∞} and f for Selected Cluster Elements

The experiment with 0.925-inch diameter, 1.007% enriched uranium rods was interrupted and postponed because of weld-failures of many of the aluminum-jacketed rods. The fuel pieces have been rejacketed and satisfactorily tested.

Coordinated Theoretical-Experimental Program

Expressions for the thermal diffusion coefficient and macroscopic absorption cross section which should be used in the homogenized equivalent of a heterogeneous lattice have recently been obtained by Selengut (Nuclear Physics Research Quarterly Report, January-March, 1959, to be issued). The thermal diffusion length predicted by these equivalent quantities is being compared with the more customary formulas, using existing exponential data.

NPR High Temperature Mock-up

The cost of the facility was judged to be too high by IPD, so no further work on this project is anticipated.

NPR Exponential Piles

Graphite and process tubes for two exponential experiments have been ordered. The final NPR fuel design is to be specified in December, with fuel delivery to follow in 2 or 3 months. Our experiments will begin as soon as enough fuel is on hand.

Mechanism of Graphite Damage

A piece of Kendall coke graphite (0.155 x 0.5 x 0.5 in.) was irradiated parallel to the extrusion direction with 50 microamperes of 1.5 Mev electrons. The dose rate in the beam, assuming 0.3 cm beam diameter, was greater than 10^{11} rad/hr. During an initial 10 minute run, the heating of the sample was enough to melt a styrofoam support. The melted plastic soaked into the sample so length change measurements were impossible. Sample heating will be extremely important from a temperature annealing standpoint, so temperature baths will be needed in future tests.

Tests of electron Van de Graaff operation at 100 microamperes, the limit set by exit window heating, showed that operation was stable and that personnel dose rates were acceptably low. There was some interference with instrument decontamination activities in the Calibrations Building.

The stability of the calorimetric system is still being checked.

Full Scale PCTR

The preliminary physics planning leading to the scope-design for the Full Scale PCTR is in progress. A brief study is being made of the possible application of small source theory to Full Scale PCTR experiments, particularly in reference to the determination of moderator temperature coefficients.

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Intercalibration of Graphite Purity

Approval has been received from the AEC to carry out an exchange of graphite samples with Dr. K. H. Beckurts, Kernreaktor, Karlsruhe, Germany.

Computational Programs and Services

Several parallel runs using the 709 Exponential Data program and the 702 Buckling program which it is replacing have been made with good results. A report, HW-60388, has been issued describing the new program and giving instructions for its use. The P-3 subroutine for the IPD lattice parameter calculation program is working. A master program permitting independent use of this P-3 program has also been written and put in operation. A report on this program is now being written. The Cofit program, to be used in conjunction with the Exponential Data Program, is in its preliminary stages. Work has also begun on a program to calculate incomplete gamma functions.

A Program for Analyzing PCTR Data

After an informal meeting of physicists interested in PCTR experiments, a decision was made to incorporate the following in the APDAC (a PCTR Data Analysis Code) specifications:

1. Computation of p, ϵ and the initial conversion ratio from foil activities.

2. Computation of the adjoint function mismatch using measured danger coefficients.

3. An analysis of data taken with several buffer configurations to determine the effect upon the inferred value of k_{oo} due to flux spectrum mismatch.

Descriptions of the above, together with a simplified flow chart for the code, are being typed and will be circulated shortly. A proposed method for averaging fluxes will also be circulated in the near future.

A detailed flow chart has been started.

Multi-thermal-neutron-group-diffusion Program

The F_n FORTRAN deck has been requested from ANPD. A copy of the F_3 deck was received and is being compared with the Hanford copy. This comparison should tell us what has been causing the difficulties encountered in trying to make the program operative. F_3 will not be modified to handle two thermal groups until the status of F_n is determined.

A multigroup program written at UCRL, Livermore, holds the promise of being very useful. ZOOM will handle up to 80 groups, all of which may contain thermal neutrons. It has been recoded, at UCRL, for the 709 and a copy of the deck has been requested.

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STUDIES RELATED TO SEPARATIONS PLANTS

Critical Hazard Specifications

Nuclear Safety in Hanford Laboratories

At the request of the Plutonium Metallurgy Operation the nuclear safety of a proposed modification to a Pu melting furnace was investigated. The original MgO melting crucible was inserted in a 2 3/8-inch I.D. graphite induction furnace. This graphite is about one-inch thick. The MgO crucibles are to be replaced by tantalum crucibles slightly less than 2 inches I.D. by 2 3/32 inches O.D. It is recommended that the 2 3/8-inch I.D. graphite furnace be replaced by a smaller one (2 1/8 inches I.D.) that makes a better fit with the tantalum crucibles. This change will not allow the tantalum crucibles to bulge (during heating) which would effectively result in a crucible of larger diameter. If this new graphite furnace is no greater than one-inch in thickness, the present operating limit of 6.4 Kg Pu can be retained.

Nuclear Safety in 234-5 Building Processing

At the request of CPD a study was made of the nuclear safety in the storage of Pu metal, oxide or fluoride powder, slag and crucible material, and solutions in a single array. The study was completed and the criteria for nuclear safety of such an array given to CPD.

Off-site Meetings Pertaining to Nuclear Safety

Two off-site meetings on the subject of nuclear safety were attended during May; these are described as follows:

Two days' sessions were attended of a five-day meeting held at Savannah River on May 25-26. This meeting was held under the U. S.-United Kingdom exchange program and was attended by representatives from Hanford and Savannah River. The purpose of the meeting was for discussion of nuclear safety, design, and plant operation in chemical processing.

The second meeting attended was held by the Division of Licensing and Regulations, Washington AEC. It was held to discuss nuclear safety problems in the shipment of irradiated power reactor fuels. In addition to discussing methods for calculating criticality parameters, bases were established for the drawing up of regulations for shipping power reactor fuels.

Analysis of a Possible Nuclear Incident in a Dissolver

The Redox Plant is currently processing "E" Metal fuel elements irradiated in the Hanford Production Reactors. These irradiated fuel elements have an effective 0.98 wt. % U-235 enrichment. The minimum critical mass for this type of irradiated fuel element is less than the capacity of the present Redox dissolvers. Consequently, nuclear safety is dependent on batch processing of the material.

Since nuclear safety is dependent on operational procedures, the possibility of a criticality incident is not inconceivable and must be considered. For

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these reasons a study has been initiated and is being carried out for the Chemical Processing Department to estimate the worst possible consequences of an incident of the maximum credible magnitude.

Plutonium Critical Mass Facility

Bids for the construction phase of the Critical Mass Laboratory were opened May 19. Of eight bids received, the lowest, for a sum of $442,025, was submitted by the Howard S. Wright Company of Seattle. After review this bid was accepted and a contract for construction was signed May 25. The contractor will have 335 days in which to complete construction after notice to proceed is given. This notice is expected within a week. In addition, bids are being received, reviewed, and purchase authorized on G. E. engineered and supplied equipment for installation by the contractor.

During the month work has been done on establishing the configuration and criteria for reactor assemblies, particularly the control and safety rod mechanisms. Design has been initiated on the in-hood equipment.

Criticality Studies in Support of Processing Power Reactor Fuels

Experiments with Heterogeneous Systems

The series of experiments for the evaluation of the extrapolation length for water reflected heterogeneous systems was continued. These experiments were made with the 3.063 percent enriched uranium rods, 0.300 inch diameter and loaded into plastic tubes to a length of 32 inches. With each lattice spacing, a full critical approach experiment was carried up to 96 percent of the critical mass at this lattice height. With the loading reduced to about 94 percent of the critical mass, horizontal neutron flux traverses were made both with gold foils within the fuel rods and with BF_3 proportional counters between the fuel rods. Cadmium ratios were measured with the gold foils to determine the region where the flux spectrum was unaffected by the reflector. This region was limited to approximately 6 inner points of the traverse. A least squares fit of each set of traverse data to the theoretical form (J_0 Bessel function) of the radial flux distribution for a bare cylinder was made. The analytical extrapolation of this distribution to zero gives the extrapolated radius of the system. This radius, less the physical radius of the uranium core, then gives the extrapolation length, λ, for the particular configuration.

A further determination of the extrapolation length may be made by equating the material bucklings calculated from critical mass measurements and from exponential experiments--the extrapolation length considered as an unknown parameter to be adjusted to bring the two buckling values into agreement. From the known dimensions (radius R_c and height H_c) of a critical system the buckling is assumed to be given by

$$B^2_{crit} = \left(\frac{2.405}{R_c + \lambda}\right)^2 + \left(\frac{\pi}{H_c + 2\lambda}\right)^2$$

and from exponential experiments the buckling is given by

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$$B^2_{exp} = \left(\frac{2.405}{R_{exp} + \lambda}\right)^2 - \left(\frac{1}{b_{11}}\right)^2 \quad \text{where}$$

b_{11} is the relaxation length determined from a vertical (axial) traverse in an exponential experiment with the radius of the system reduced to some R_{exp}. Such exponential measurements were made for each of the lattice spacings at the 32-inch height. These, together with the results of the previous critical mass measurements at the 16-inch height were used to obtain a value for the extrapolation length.

Values of the extrapolation lengths are given in the following table. The "Type of Data" indicates the detector, number of points used for the least squares fit, or the critical dimensions-exponential experiment buckling comparison. Unless otherwise noted the flux traverses were made at the vertical mid plane (16 inches from the ends). Preliminary figures for the 0.700 and 0.800 inch spacings have been reported (HW-60233B) and are included for completeness.

EXTRAPOLATION LENGTH FOR 3.063% ENRICHED URANIUM

Lattice Spacing (Inches)	H_2O/U (Volume)	Type Data	λ Cm.
0.6	3.41	Au Foil - 7 pts.	6.41
		Au Foil - 6 pts.	6.61
		Au Foil - 7 pts.	6.60
		Au Foil - 6 pts.	6.48
		BF_3 - 7 pts.	6.91
		BF_3 - 6 pts.	6.61
		$B_{Exp} = B_{CA}$	6.50
0.7	5.00	Au Foil - 6 pts.	5.99
		Au Foil - 5 pts.	5.38
		BF_3 - 6 pts.	6.70
		BF_3 - 5 pts.	6.13
		$B_{Exp} = B_{CA}$	6.07
0.8	6.84	Au Foil - 6 pts.	6.07
		Au Foil - 5 pts.	5.71
		BF_3 - 6 pts.	7.00
		BF_3 - 5 pts.	6.22
		$B_{Exp} = B_{CA}$	6.20
0.9	8.92	Au Foil - 6 pts.	6.08
		Au Foil - 5 pts.	6.25
		BF_3 - 6 pts.	6.71
		BF_3 - 5 pts.	6.74
*		BF_3 - 6 pts.	6.89
*		5 pts.	6.46
**		6 pts.	6.65
**		5 pts.	6.30
		$B_{Exp} = B_{CA}$	5.93

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* - 8 inches from bottom of fuel.
** - 24 inches from bottom of fuel.

The following table lists the critical mass measured for each lattice spacing by the critical approach experiment for the 32-inch height. In addition, for comparison, are shown the material bucklings calculated from these data, the previous critical approach measurements at the 16-inch height and from the exponential measurements. All buckling calculations were made with the common λ shown. These results are as follows:

Lattice Spacing (Inches)	H_2O/U (Volume)	Measured Critical Mass (32-inch High) (lbs.)	λ (Cm.)	Calculated Bucklings ($cm^{-2} \times 10^{-6}$) Exponential Data	Critical Approach Data 32 in. High	Critical Approach Data 16 in. High
0.6	3.41	460	6.62	14,928	14,889	14,956
0.7 *	5.00	355	6.50	14,599	14,658	14,778
0.8 *	6.84	312	6.50	13,262	13,421	13,383
0.9	8.92	315	6.50	11,294	11,462	11,490

* Reported previous month.

The exponential measurements have standard error from least square fit that varies from 7 to 25 micro-bucks. The buckling calculated from critical approach data has an estimated standard error of about 25 micro-bucks. The extrapolation calculated by setting buckling equal would have a standard deviation of about 0.1 cm. The errors in the horizontal flux fitting give an estimated standard deviation in the extrapolation length of about 0.26 cm due to counting statistics.

Experiments with Homogeneous Systems

Analysis of the data from k_∞ measurements in the PCTR at nominal H/U ratios of 4 and 6.5 has confirmed the equivalence of polyethylene and water as moderators for these k_∞ measurements.

Analysis of the data from measurements of the resonance escape probability, P, in the PCTR gives P_{H_2O} moderated = 0.82 at H/U = 4.6. A value of P_{CH_2} moderated = 0.85 at H/U = 4.0 was obtained but is suspected to be in error because the data were taken during a period later found to be one of scintillation counter trouble and also because the k_∞ values for the cases of the two moderators agreed so well.

Neutron Age Measurements

The energy spectrum and angular distribution of neutrons produced in the Na-Be sources used in these measurements have been calculated. The angular distribution was found to be very anisotropic, and as a result the theoretical calculations made elsewhere on the effect of source size on the neutron age are not reliable. The results of these experiments are being prepared for publication.

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Critical Mass Theory

Writing has started on a FORTRAN program to integrate the N + 1 coupled first order differential equations describing reactor kinetics with N groups of delayed neutrons. Provisions are included to permit either the reactivity or one geometrical dimension to change linearly with time. The attempted analog computer solution to this problem was not successful.

NEUTRON CROSS SECTION PROGRAM

Pu^{241} Fission Cross Section

The uniformity of deposit of several of the electrodeposited foils used in these measurements has been studied by fission counting in small areas of the foils. The nonuniformities which were observed ranged from ± 9 percent for the best foil to ± 15 percent for the worst. This nonuniformity is much more severe than had been anticipated and will make it impossible to obtain detailed information on the shape of the 0.26 ev resonance.

The overall measurements in the 4 to 23 ev region have been completed and individual resonances are being run with higher resolution. A higher resolution run of the 4.3 ev resonance confirmed the presence of a small resonance at 4.7 ev.

Slow Neutron Scattering Cross Sections

The three axis spectrometer has been put back into operation following the extended reactor outage. The study of the energy distribution of 0.184 ev neutrons scattered from room temperature water was completed and measurements are now being made with an incident neutron energy of about 0.22 ev.

Fast Neutron Cross Sections

The new model of the vernier chronotron has been performance tested as a time-of-flight clock. The channel width of the new model is constant with counting rate which eliminates the most grievous problem of the original model. The gating transient which inactivates the chronotron for the first few channels is shorter and less severe than with the original model. The resolution is at least equal to the original model as 0.85 m μsec resolution was obtained for the Co^{60} coincident gamma decay with a lesser restriction on biasing than was previously used.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Low Exposure Plutonium Lattices

Fabrication of graphite is essentially complete. Some metal components have been delayed by a strike against the off-site contractors.

The 1.8 w/o Pu-Al fuel will not be delivered on schedule. The best estimate at present is late in July 1959.

PCTR Experiments

Some P_3 calculations have been run on a PRTR cell with the fuel replaced by a homogenization of a cluster of small diameter, highly self-shielded Pu rods. These results have not been analyzed as yet.

Exponential Experiments with Plutonium-Aluminum Rods

In reference to critical mass studies for processing plutonium bearing fuel (PRTR) the first delivery of the specially prepared Al-Pu alloy fuel rods was made by the Plutonium Metallurgy Operation. On May 14, 60 rods, each two feet in length and containing a total of 641.3 gm of Pu, were received. The total number of rods to be supplied includes 200 Zircaloy-2 clad rods two feet in length and, in addition, 20 rods one foot in length. The fuel alloy is aluminum - 5 w/o Pu: the diameter of the rods is 0.5 inch; the fuel cladding is 30-mil thick Zircaloy-2; the maximum O.D. of the clad elements is 0.576 inch.

Nuclear Safety Problems

During the preceding month a nuclear safety study was made for the Plutonium Metallurgy Operation for the shipment of large quantities of 7 percent (by weight) Pu-Al alloy fuels. The results of this study were reported in the April Monthly Report (HW-60233B). Another study was made of the nuclear safety in the air shipment of these fuels spaced on 4-inch centers. It was determined that 36 of these fuel elements at this spacing would be safe provided the only material inside these boxes other than fuel was the 1/2-inch plywood sections required to maintain the lattice spacing between fuel rods. This array would be safe if water flooded.

The limits on the amount of wood inside the boxes is to preclude a wood-moderated reactor. If the entire space in these boxes not occupied by fuel were filled with wood, it is estimated that as few as 40 of these rods might be critical.

A meeting was held with a member of the PRTR Operation to discuss criticality in the case of a PRTR fuel meltdown. This hypothetical case considers the loss of moderator and coolant with subsequent meltdown of the fuel. For the purpose of the discussion all 85 fuel elements were assumed to be Pu-Al elements (1.8% Pu by weight) each containing a maximum of 270 grams Pu. Provided there is no boil off of aluminum from the molten alloy, such a meltdown cannot result in a critical condition.

Instrumentation

The focusing effect of the profilometer diameter measurement unit was corrected by regrinding one of the surfaces of the variable wedge. Electric motors were selected for five of the control functions of the profilometer. Manual controls are being designed for the diameter and warp measurement functions. Digital readout counters have been selected to indicate warp and diameter measurements. The counters will provide a check on the automatic printout system and could be used if the printout system were temporarily out of order.

A count-rate system for checking the thickness of the zirconium cladding around the uranium fuel element will be evaluated.

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GAS COOLED REACTOR PROGRAM

Lattice Parameter Measurements

Preliminary analysis of the data obtained from the first experiments in the PCTR yields the following information:

	PCTR Lattice	GCR Lattice
$f_{poisoned}$	0.699	--
f	0.807	0.819
k_{∞}	1.155	1.172

The GCR lattice was not easily mocked up exactly in the PCTR. The above numbers indicate the magnitude of the correction necessary to account for the difference in the two lattices. The details of the two lattices will be given when final numbers for k_{∞}, f, p, and ϵ are available.

The second measurement, that of control rod strength, has been completed this date. A preliminary look indicates that the control rod strength is greater than 20% in k_{ex}, compared to the original value of 14.8% calculated by Allis-Chalmers. Recently, calculations at Oak Ridge have predicted a value of about 28%.

Variation of Doppler Coefficient with S/M Ratio

The bid for a 7 1/2 KW induction heating generator has been awarded to Lepel High Frequency Labs, Inc. at $4694.00 + $160.00 freight. Delivery is scheduled for June 19, 1959.

The thermocouples for the mockup, together with the modified recorder, are being calibrated in the 300 Area, Instruments Standards Shop.

Fabrication of the 20-inch length of fuel element for the 1.92-inch diameter temperature coefficient is about 75 percent complete.

Theoretical PCTR Studies

A simplified small source theory critical condition, in the form of a 4 x 4 determinant, was solved numerically for the GCR lattice with one control rod per nine fuel elements. This condition was used to predict a thermal utilization of f = 0.706, based on a measured value of f = 0.807 for the lattice without control rod. The predicted control rod worth of about 12.5% in k is approximately half the experimental value, which is still tentative but exceeds 20%. This discrepancy is believed to be due, in large part, to the inclusion in the criticality formulation of the lattice sum of K_0 functions only. As a step in the process of including lattice sums involving K_n for $n > 0$, the formal lattice sum for general n has been found by use of the Poisson summation formula. This general result is now being checked.

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TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month with one unscheduled shutdown caused by electronic failure. The control rod effectiveness experiment for the Gas Cooled Reactor was completed as was the first phase of the 1 percent enriched 7-rod cluster k_{∞} determination.

An extended outage for maintenance and reactor improvements is being planned. The floor under the moving face tracks is to be reinforced; an 11-inch square hole is to be made through the moving face; and a safety railing installed on top of the reactor. Estimates have been prepared and the Work Review papers are being processed.

Designs were completed and work orders written for a core volume jig and a fine control rod drive. The core jig will allow stacking the entire test assembly prior to charging into the reactor. Reactor time efficiency can be improved by ensuring that no rebuilding will be required after loading the assembly into the reactor. The fine control rod is to be used in following small changes in reactivity, such as those occurring in fuel temperature reactivity coefficient measurements.

Critical mass experiments were conducted in the TTR reactor room during the entire month.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

Preparations for this summer's field experiments neared completion and the first partial experiment, designed to test equipment and operating schedules, was scheduled for the first week in June. All equipment was in hand and installed on June 4. The major remaining item was calibration of the automatic pigment counters, a task which requires the samples collected in the partial experiment mentioned above.

Supporting functions from Texas A and M and the Air Weather Service began to arrive during the latter part of the month. Full-scale field experiments were tentatively scheduled to begin on June 15 and no later than June 22.

A further transfer of funds, in the amount of $30,000, was effected between the Air Force and HOO-AEC by Cross Servicing and Acceptance Order No. 59-542. These funds are in support of the data reduction and tabulation associated with this summer's experiments, as well as further support for field activities.

Dosimetry

It was decided to complete the assembly of the large scintillation counter for the Shielded Personnel Monitoring Station. An array of seven 3" photomultiplier tubes will be used. The 10" EMI tube has still not been received for testing.

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During a trip to Los Alamos, the K^{40} and Cs^{137} burden of the physicist working at the station was measured. The agreement with our own measurements was acceptable. During the month, 26 people were counted either for routine sampling or as a suspected contamination case. Determinations of Cs^{137}, K^{40}, and Zn^{65} body burdens were made for the routine cases. Analysis of the data is not complete; however, a plot of potassium content versus body weight was similar to that obtained at Los Alamos. The average Cs^{137} content was 83 μμc/gm K; according to Los Alamos the national average for 1958 was 67 μμc/gm. Zn^{65} appeared in several Pasco and Kennewick residents who were measured.

Eight cases of suspected contamination were examined. Six showed no contamination. One of these was a second subject involved in the glove box explosion reported last month. One subject showed Sc^{46} and Zn^{65} and another showed Ru^{106}.

The positive ion Van de Graaff operated satisfactorily during the month. Sparking near 2 Mev was reduced by opening the tank and cleaning out metal dust from the stapled belt. Drifts in the magnet current were reduced after it was found that mercury batteries in an integrating servo were affected by temperature changes; the batteries were mounted in a place less subject to change. Enlargement of the control room and addition of a light floor over the pit in the accelerator laboratory were begun. A vacuum system for preparing accelerator targets was assembled.

Measurements and analysis of data for alpha-radioactive neutron sources continued. To check the reliability of the counter system, the double moderator was used for the measurement of background. The data appeared to be statistically reliable. The background rate showed variations of as much as 48%. The ratio of counts with the two moderators, however, showed only small fluctuations.

The threshold energies for the excitation of the 5.11 and 5.16 Mev levels in B^{10} were measured with the double moderator by observing, in the direction of the beam, the ratio of counts with the two moderators as a function of deuteron energy. Preliminary values obtained for the threshold energies were 0.914 and 0.975 Mev. Bonner and Butler obtained 0.920 and 0.980 Mev in 1951. The study was made to show that the improved performance of the accelerator with the stapled belt can improve our knowledge of the $Be^9(d,n)\ B^{10}$ reaction.

In studies of the use of pencil ion chambers for low dose measurements, four 6-volt storage batteries were substituted for the chopper-stabilized electronic power supply for the charging voltage. The batteries proved to be more stable than the power supply. It was possible to measure 1 mr doses to accuracies of about 1.5% with a given pencil. It was found that different pencils produce charges per unit dose that differ by more than this so individual calibrations are necessary. Linearity was checked and found to be excellent. A draft of a journal article on this work was prepared.

With the cooperation of Components R & D Operation an optical pyrometer was tested for use as a sensitive densitometer for differential densitometry of film badges. The results looked promising for improvement of the sensitivity of film badges.

INSTRUMENTATION

The scintillation transistorized combined alpha-beta-gamma hand and shoe counter is still in completely satisfactory operation in the 329 Building. The instrument has operated for almost three continuous months with no maintenance work necessary. The instrument has undergone approximately (estimated) 10,000 operations in the three months with no known faulty or incorrect operations or indications.

A radiation picture and a daylight photograph were taken simultaneously with the experimental pinhole camera on the rear face of 100-KE during the last shutdown. The daylight photograph was satisfactory; however, the radiation photograph was ruined in the developing process. Another set of photographs will be taken soon.

Investigation and development work was done concerning a completely transistorized scintillation dose-rate meter. Two methods of approach are being investigated; these are a chopper-input with following a-c amplifier and a much simpler and cheaper d-c system using a differential transistor amplifier for good temperature compensation. Approximate ranges of the experimental instrument with the differential transistor amplifier are 0-5 mr/hr, 0-50 mr/hr, 0-500 mr/hr and 0-5 r/hr. It is hoped that this can be improved to one mr/hr full scale first range. This can be done by raising the high voltage or using different transistors.

A completely transistorized scintillation alpha-beta-gamma aurally indicating instrument has been developed and the various circuits "breadboard" tested. The aural (loudspeaker) output is in the form of loud pops for each alpha-caused pulse and a one KC note or "chirp" for each beta-gamma-caused pulse. Thus, ear separation of the two types of contamination is easily obtained. The system will easily detect and indicate pulses from beta energies as low as 75 to 100 Kev; thus, C^{14} and S^{35} are easily detected. The alpha background is less than three counts per minute with an alpha-detecting geometry of 10 to 15%. A complete experimental instrument will be fabricated soon. This transistorized system can be used in place of the vacuum tube model designed last year. Five of the vacuum tube models were fabricated and all have worked satisfactorily. The transistorized model has the advantages of better stability, lower maintenance costs, and lower initial cost.

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

The two experimental scintillation nuclear-incident alarm instruments were tested at Los Alamos using the "Godiva" test facilities. The tests were completely satisfactory in all cases with both instruments. In all tests but one, the alarms energized. In the one test where the alarm did not energize, it was found that the field strength level for the particular test, at a very remote location, was not quite high enough to cause relay closure with a one r/hr alarm point. The total "Godiva" output is about 10^{16} nvt with a pulse width of about 40 microseconds. The tests were made both with and without the use of the two-transistor booster amplifier. An inexpensive and very stable terphenyl-in-polyvinyltoluene crystal detector is used in the instrument. The variable alarm set

point can be set for any gamma dose-rate level from about three mr/hr up to ten r/hr.

Circuit changes were made in the wind speed integrator and identification units of the radiotelemetering system. Units in the field are being replaced with these modified units. Circuit modifications were made on the scanning switch chassis, the wind direction integrator chassis, and the main chassis of the data stations. These modifications have been made on all data stations.

Two more sources which were received for the Zinc-Sulfide Particle Counter were acceptable. Two extra sources will be tested. All four units are now ready to be used by the field except for one scaler which has not been delivered.

Some investigation work has been carried out to determine the efficiencies of various light pipes. These scintillation-type probes, with an effective diameter of three mm, were evaluated for alpha and beta detection. For evaluation purposes, point sources were used. The alpha detector has a counting efficiency of 10%. A 4280 d/m or 1.93×10^{-3} µc Pu^{239} source was used. The beta detector has a counting efficiency of approximately 0.28% for a C^{14} source of 4660 d/m or 2.1×10^{-3} µc and a counting efficiency of about 2% for a Cs^{137} source of 1.18×10^{6} d/m or 0.532 µc.

A Shaw pryometer was tested for use as a densitometer. This work was done in assistance to W. C. Roesch. The commonly used densitometers read density differences of 0.05 density units. It was found that the Shawmeter used in conjunction with other optical equipment could read differences of 0.005 units and there is some possibility of reading even small differences since the experimental arrangement for these tests was rather crude.

WASHINGTON DESIGNATED PROGRAM

Analytical services were provided for this program.

A modification is being made to the scalers of the ion counting detection system. Tests indicate a reliable performance will be obtained with the modified scaler. A new 10-megacycle discriminator is being fabricated to replace the discriminator now in use which has been unsatisfactory.

A portion of the Pu^{241} sample being used for fission cross-section measurements was analyzed in the triple filament mass spectrometer. The results obtained for the ratios Pu^{239}/Pu^{241} and Pu^{240}/Pu^{241} agree with the previous analysis by Oak Ridge to within ± 2 percent.

CUSTOMER WORK

Analog Computing

Problem solutions are being delayed due to equipment limitations. Most of the NPR work requires function generators and our present ones cannot be used because of bad components. Emergency orders were placed for the components necessary to repair the function generators. The estimated delivery date for these components is mid-June.

The PRTR work is awaiting the arrival of some "transport lag" equipment being borrowed from Berkeley (Div. of Beckman Instruments).

The computer was down for approximately a week to replace some burned out resistors in the power supplies and for a complete tube check.

The DDA is out of operation until a bad rectifier is replaced.

The Primary Coolant Transient Analysis for the PRTR has been programmed, but a shortage of usable equipment and a lack of special equipment has delayed its solution. It is expected that the problem will be put on the computer the first week of June.

The study of the pump coastdown curves for the NPR has been completed. A report covering this study will be issued in the near future.

The log simulator was programmed on the computer and worked well for certain ranges of reactivity as a linear function of time; however, for the range in which the theoretical physicists were interested, it was unsatisfactory due to scaling problems which entailed an unreasonable long running time to arrive at the solution.

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	87.6
24-Hour General	62	82.7
Special	135	93.3

A temperature average of 57.5 established the past month as the fourth coldest May in 48 years of record for the Hanford Area. The coldest May of record was in 1933 when temperatures averaged 56.6. A feature of temperatures for the past month was a sudden warming from a high of 66 on the 11th to 91 on the 13th, and then a sudden cooling to a high of only 57 on the 15th.

May was the third consecutive windy month. However, the average speed of 9.3 mph was considerably less than the record 11.1 mph average of April.

Instrumentation

The experimental radiation warning device is essentially completed, in fabrication, for the Facilities Engineering Operation, Hanford Laboratories Operation. The scintillation detector instrument, with minimum alarm sensitivity of about five mr/hr, will be used as an alarm monitor above a water-filled tank containing a 15,000 curie Co^{60} source. The alarm-point sensitivity is to be settable from about five mr/hr up to 100 mr/hr.

Fabrication work was completed on the experimental conversion of a vertical lead pig-type shelf counter from a fragile expensive mica-window GM tube detector to a scintillation system using a phototube and terphenyl-in-polyvinyltoluene detector. With a C^{14} (beta = 158 Kev) check source, the signal-to-background ratio was 25% better using the scintillation detector in place of the mica window GM tube with the source to detector face distance the same in both cases. Not all

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of the very old and obsolete GM tube systems can be similarly converted since the older scalers in use at HAPO have such poorly regulated and noisy high-voltage supplies. Systems using scalers manufactured in the last four or five years can probably be simply and easily converted to scintillation counting for stable reliable operation.

The analytical calculator is approximately 50% finished. The calculator will be assembled and ready for testing during the first week in June.

A gross count instrument has been designed for Coolant System Development of the Materials Development Operation. The instrument uses a terphenyl-in-polyvinyl-toluene crystal and multiplier phototube detector with a linear amplifier and count-rate meter circuit. It will give count-rate data on the level of contamination of samples for decontamination studies.

It was requested that we investigate the possible application of scintillation equipment to replace the mica window tube and equipment presently used to monitor masks in the laundry. After several laboratory tests, using masks furnished by the field, a memorandum was prepared describing a system which will reduce monitoring time by 80% and maintenance cost to a very low figure.

Evaluation tests were completed on the Riggs Remote Area Monitor and the "Scintran" scintillized, transistorized, ac-operated poppy-type alpha detector. Re-evaluation of the German pocket alarm was completed. Evaluation tests were started on the Spear scintillized, transistorized, battery-operated, portable, fast and slow neutron detector, and the Tracerlab Remote Area Monitor. Field tests were performed on the redesigned gamma energy analyzer. A library search on tritium monitors was started and work was done on getting data on cold cathode trigger diodes. These could perhaps be used as voltage sensitive relays and would find application in pocket dose alarms.

Optical

The routine Optical Shop work during this period included a total of 520 man-hours of which 31% was for Spare Parts (Stores - ultimate customer is CPD), 4% for FPD, 15% for IPD, 27% for HLO (including 16 manhours sick leave) and 23% for CPD. The work included:

1. Fabrication of 29 glass bearings.
2. Polishing one bearing seal face.
3. Polishing three lead glass bricks.
4. Servicing one three-power crane periscope head for Redox.
5. Design and fabrication of a test probe for detecting differences in fuel element surface reflectivity.
6. Fabrication of 12 photometer windows.
7. Aluminizing 15 mirrors.
8. Fabrication of two lens holders for 327 Building.
9. Fabrication of a lamp and photocell assembly for G. R. Klinger of IPD.
10. Fabrication of parts for a beta-ray can wall thickness detector.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
S. Glassman R. D. Schamberger	5/5	Nuclear Development Corp. of America White Plains, N. Y.	Discuss Application of PCTR Techniques.	RA Bennett HL Henry	No	300: 326
Albert Sheldon	5/6	Electronic Associates, Inc. El Segundo, Calif.	Discuss computer equipment.	HH Burley WD Cameron GR Taylor	No	300: 326
O. J. Judd	5/13-15	Rush Drake Associates Seattle, Wash.	Discuss analog computer techniques.	HH Burley WD Cameron GR Taylor	No	300: 326
J. E. Sperry W. H. Butler	5/15	Brush Instruments Seattle, Wash.	Discuss analog computer equipment.	HH Burley WD Cameron GR Taylor	No	300: 326
Lynn Watson	5/15	Ampex Corporation Redwood City, Calif.	" "	HH Burley WD Cameron GR Taylor	No	300: 326
C. C. Gamertsfelder	5/15	General Electric Aircraft Nuclear Propulsion Dept.	To discuss biology experiments.	WC Roesch	Yes	300: 329
B. W. Shumway	5/27	USNRDL San Francisco, Calif.	To discuss radiation dosimetry.	WC Roesch J DePangher HV Larson	Yes	300: 329 3745-B

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access To Restricted Data
R. A. Harvey	4/30 5/1,7-8, 14-15,21- 22, 27-28	Univ. of Washington Seattle, Wash.	Assist in teaching EE 510.	Prof. Eastman	No
C. R. Lagergren D. G. Foster E. D. Clayton	5/1-2	Am. Physical Soc. Washington, D. C.	Attend APS Meeting.	--	No
W. C. Roesch	5/1	Columbia Univ. New York, N. Y.	ICRU Committee on Quantities & Units.	H. H. Rossi	No
I. T. Myers	5/1 5/14-15 5/28-29	Univ. of Washington Seattle, Wash.	To teach AEC Fellowship class.	Faculty & Students	No
R. C. McCall	5/1-2	Am. Physical Co. Washington, D. C.	Attend meeting.	--	No
	5/4-6	Mass. Inst. of Tech. Cambridge, Mass.	Discuss whole body Counter.	R. D. Evans	No
	5/6	Veterans' Hospital Rochester, N. Y.	" " "	G. J. Hine	No
	5/8	Univ. of Rochester New York, N. Y.	" " "	J. B. Hursh	No
	5/11	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	" " "	E. R. Cofield J. A. Harter	No
	5/13	Los Alamos Scientific Laboratory Los Alamos, N. Mex.	" " "	M. A. Van Dilla	No
E. D. Clayton	5/4	Brookhaven Nat'l Lab. Upton, N. Y.	Discuss critical mass experiments.	H. J. Kouts	Yes

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. G. Foster	5/4	Nuclear Development Corp. of America White Plains, N. Y.	Discuss neutron age experiments.	H. Goldstein	Yes
	5/5	Knolls Atomic Power Laboratory Schenectady, N. Y.	" " "	C. R. Mullin	Yes
E. D. Clayton	5/6	Kansas State College Manhattan, Kans.	Present a talk to Dept. of Nuclear Engineering (University Relations)	--	No
W. C. Roesch	5/7-8 5/21-22	Univ. of Washington Seattle, Wash.	Teach AEC Fellowship class.	Faculty & Students	No
N. Ketzlach	5/11	Atomic International Los Angeles, Calif.	Interview.	N. C. Miller	No
	5/12	Atomic Power Equipment Department San Jose, Calif. & Vallecitos, Calif.	"	Merrill Hall R. W. Trevithick	No
	5/13	General Atomic San Diego, Calif.	"	Mr. Hoyt	No
G. R. Hilst	5/13-14	Stanford University Stanford, Calif.	Confer with personnel on diffusion measurements and analyses.	W. A. Perkins	No
		Stanford Res. Inst. Menlo Park, Calif.	" "	D. H. Hutchison	No
G. E. Driver	5/13-25	Knolls Atomic Power Laboratory Schenectady, N. Y.	Discuss fuel elements rupture detection and attend Symposium on Semiconductor Applications.	L. J. Cherubin	Yes

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
C. R. Lagergren	5/17-22	Committee E-14 of ASTM Meeting Los Angeles, Calif.	Mass Spectrometry.	--	No
D. S. Selengut	5/19-20	Engineering Computer Users Symposium Philadelphia, Pa.	Attend symposium.	--	No
J. DePangher	5/20	Wash. State Univ. Pullman, Wash.	Deliver two talks.	Prof. E. E. Donaldson & Faculty	No
N. Ketzlach	5/25-26	Savannah River Plant Augusta, Ga.	Attend joint UK-USA meeting on chemical processing and criticality problems.	--	No
	5/27	Washington, D. C.	Meeting on methods of making nuclear safety calculations for shipments.	Clifford Beck	Yes
A. L. Ruiz	5/26	Atomic Products Equipment Dept. San Jose, Calif.	Discuss methods of analyzing xenon poisoning of reactors.	W. H. Harker	No
E. D. Clayton	5/28-6/22	Eurochemic, Mol, Belgium	Consulting on critical mass problems in chemical processing plants.	E. L. Nicholson	No

1240401

Chemical Research & Development

RESEARCH AND ENGINEERING

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATION PROCESSES

Decontamination of Reactor Components

Permanganate-carbonate solutions are slightly less effective than permanganate-caustic solutions for fission product decontamination as the first step in the APACE process. Further experiments with the APACE process indicate little benefit is gained from the Versene (EDTA) used with ammonium citrate in the second step of the APACE process. Reducing the temperature from 95 to 60 C during Step 2 of the APACE process reduced decontamination of stainless steel by a factor of at least 10 but did not reduce decontamination of carbon steel.

Uranium Oxidation and Fission Product Volatilization Studies

A series of experiments to characterize the evolution of fission products at high temperatures in steam atmospheres was begun and five runs successfully completed. Partial analytical results indicated that much smaller percentages of fission products would be released in a steam atmosphere than in air under otherwise similar experimental conditions.

Preparation of a summary document on the release of fission products in an air atmosphere was started.

Progress was made in specifying and testing equipment required for the high exposure uranium meltdown studies. Purchase specifications were prepared for all major equipment with exception of manipulators. Arrangement was made to test Brookhaven-type manipulators prior to writing purchase specifications. Counting equipment, flowrator, and temperature recorder were specified.

A scintillation counting procedure was developed for measuring the percentage of xenon by direct counting of charcoal traps utilized in the experimental equipment of the fission product release study. This provides an easier and more accurate method for rare gas determination than previously available.

Analytical Services

Water in compressed air was measured with Karl Fisher agent by reversing the normal titration. The air was passed through a measured amount of KF agent. The air titration was followed by metering the air leaving the titration cell. The standard potentiometric end-point was used.

Monthly Mn^{56} ($t_{1/2}$ = 2.6 hrs.) measurements were begun on Pasco raw and Pasco sanitary water samples. Mn is oxidized to the permanganate in a one liter

aliquot, reduced to MnO_2 filtered and the filter paper placed in a one dram vial for gamma counting in the well of a 3-inch x 3-inch NaI (T_1) crystal. A sensitivity of 2×10^{-7} uc/ml is achieved.

SEPARATION PROCESSES

Recovery of Neptunium in Purex. Additional flow sheet development was required in behalf of the most recent Purex Plant recovery run, completed during the last week of May. The need for further development stemmed from the desire to accomplish the recovery and concentration of neptunium in the 2A and 2B columns alone (vice 2A, IBX, IBX, and 2B in the April run), to operate the 2A and 2B columns at elevated temperature, and to add all the necessary reducing agents via the 2AS stream (vice addition via both the 2AS and the 2AF in the April run).

Purex 2B Column Studies. Cold semiworks studies confirmed the results reported in April; i.e., that approximately a ten per cent capacity increase is obtained by increasing the 2B column temperature from 35 to 50 C at a pulse frequency of 30 cycles per minute.

Miniature mixer-settler tests indicated that satisfactory neptunium recovery and neptunium-plutonium partition could be obtained with about half as much ferrous sulfamate and hydrazine as was used in the April run and that these chemicals could be safely added in the 2AS stream only (0.15 M ferrous sulfamate, 0.15 M hydrazine in 2AS). Similarly, Mini tests showed no loss in neptunium-plutonium partition when the 2A unit was operated at 50 C.

Experience to date in the plant run has confirmed these observations. However, some difficulty was encountered in the early stages of the plant run in establishing appropriate flow ratios and acidities to enable separation of the neptunium from the abnormally large amount of uranium present in the 3WB (ca. 0.5 M U in this feed vice 0.2 - 0.3 M in earlier runs). A procedure which appears attractive for future runs would entail "loosening" the 2D column flow sheet to enable the uranium concentration in 3WB to be reduced immediately prior to shutting down for neptunium recovery. Some loss in fission product decontamination of uranium would result from such operation but this uranium could be substituted for the cold uranium which is normally recycled during startup and any excess over that required for this purpose could presumably be decontaminated by silica gel treatment.

Recovery of Neptunium by a Specific Extractant

Recovering neptunium by a special solvent extraction cycle could offer increased flexibility over intermittent or continuous recovery and purification in the Purex Plant. For example, solvents other than TBP can be considered and, indeed, dibutyl butyl phosphonate ($Bu(BuO)_2PO$, the only other organophosphorus solvent presently available in commercial quantities) appears to offer certain advantages. For example, batch equilibrations of 30 per cent DBBP with synthetic 1WW solutions yielded neptunium distribution ratios of 9.9, 1.8, and 3.3 at acidities of 4, 7, and 2 M HNO_3, respectively. By contrast, distributions with 30 per cent TBP were only 0.2 and 1.0 at 4 and 7 M HNO_3, respectively. Similarly, excellent separation

of neptunium from both uranium and thorium(UX_1) should be possible in a "C" column employing DBBP. With a strip solution containing 0.35 M HNO_3 and 0.03 M Fe^{+++}, the neptunium (V?) distribution was only 0.01, whereas data published by T. H. Siddall[1] indicate distribution ratios of about 20 for uranium and 5 for thorium in such a system with 30 per cent DBBP. Thus, a two-column reflux cycle with 30 per cent DBBP should enable effective separation of neptunium from uranium, thorium, and fission products from a fairly low acid 1WW.

Determination of Neptunium(IV) Complexing Constants

The first and second complexing constants of neptunium(IV) with chloride, nitrate, and fluoride have been determined in 2 M perchloric acid by TTA extraction using the method of Leden. The values found for k_1 and k_2, respectively, were 0.78 and 0.69 for chloride, 1.7 and 2.9 for nitrate, and 1.9×10^6 and 3.3×10^6 for fluoride, all at 25 C. The only previously reported neptunium(IV) complex data were for the sulfate (k_1 and k_2 equal 3.2×10^3 and 1.3×10^2). These were confirmed in testing the method. Measurement of the phosphate and oxalate complexes is complicated by low solubility. The acetate, sulfamate, and semi-carbazide complexes are too weak for measurement by this technique. Iodide was not sufficiently stable. The citrate and thiocyanate complexes are under study.

Tritium Processes

Very satisfactory enrichments of hydrogen-deuterium mixtures were obtained using "Raney" palladium dispersed on asbestos and packed into a 120 cm long by 0.9 cm ID column with the aid of mechanical vibration. Using the hydrogen displacement technique, a sample of hydrogen containing 36 per cent deuterium was enriched to 96 per cent, the product containing 88 per cent of the deuterium originally in the feed sample. The separation factor was 45 with a calculated HETS for the column of 22 cm. It is believed that this very encouraging result (which is comparable to the results of Glueckauf and Kitt) is primarily due to the mode of packing, a factor which will be further investigated.

Analytical Services

Relative abundances of gamma rays of eight energy levels (0.017 to 1.28 Mev) were measured for each section of the Z Plant production line. Measurements were made on site with a single channel gamma spectrometer with 2-inch and 1 mm thick NaI (T_1) crystals. Radiation fields up to 40 mr/hr required collimation of the sources. Absorption measurements for various thicknesses of lead glass were also made.

Iron was determined in the presence of macro quantities of plutonium by controlled potential coulometry titration. Percentages of 0.046 and 0.086 were determined in samples having Pu/Fe weight ratios up to 218. Precision was one per cent. Nitrates limited the tolerance for plutonium to approximately 15 times the iron molarity.

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(1) Siddall, T. H., Extraction of Uranium and Other Actinides from Nitric Acid by Di-n-butyl n-butylphosphonate, DP-219, June, 1957 (Confidential)

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WASTE TREATMENT

Semiworks Fluid Bed Calciner

Over-all fabrication of the calciner prototype equipment is 95 per cent complete. Installation of the calciner, surface condenser, scrubber, and spray condenser is complete. Installation of the electrical equipment has been started.

ANL Fluid Bed Calcination Studies

Exploratory studies at ANL on fluid-bed calcination of Purex acid wastes have continued. Recent work has been performed with simulated "formaldehyde-killed" and concentrated waste at a bed temperature of 500 C and a feed rate of 4.8 liters/hour. Operability and results continue to improve. Two 16-hour runs (voluntarily stopped) were recently completed. The powdered product in these runs contained fewer large agglomerates and had a higher bulk density (1.4 g/cc) than in any previous runs.

The main difficulty, at present, is the frequent plugging at the feed nozzle. This plugging has been identified as being a major contributor to the formation of undesirably large particles. Future runs will include the use of modified feed nozzles in an attempt to reduce nozzle pluggage and agglomerate formation.

Heat Transfer Properties of Spray-Calcined Waste

Studies have been made in the 4-inch diameter 2-foot long heating unit to determine the heat transfer properties of the calcined waste produced in the Chemical Research spray calciner. These studies indicated that the thermal conductivity of the spray calcined material is much lower than that of the 120-mesh alumina powder discussed in February's report. At heat generation rates of 10,000 and 8,000 Btu/(hr)(cu.ft. of powder), temperatures of 800 and 700 C, respectively, were noted at the center of the heater using the spray calciner powder. With 120-mesh alumina at approximately the same heat generation rate, the temperature at the center of the unit was approximately 350 C.

Observation Wells

No new trends in the movement or degree of ground water contamination were evident. The Co^{60} concentration in the ground water beneath the 216-BY cribs continued to decrease, the maximum concentration detected being less than the M.P.C. for drinking water. A single sample from a well south of 200 East Area was found to contain significantly more (five times) gross beta emitters than previous samples. This must be confirmed in additional samples before the finding can be considered significant.

Six monitoring wells close to the 216-BC cribs were examined with a gamma scintillation probe. No measurable downward movement of gamma emitters was evident in four of the wells, but in the two southern wells additional downward migration of 10-15 feet was evident. A new well about 50 feet south of the cribs showed measurable gamma activity over the entire depth to the water table,

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340 feet. Gamma activity cannot be detected all the way to the water table in the closer wells. These data are interpreted to indicate lateral spreading of the wastes from the 216-BC cribs in a steeply-dipping southerly direction.

Disposal to Ground

An analysis of the historical data on the Redox 216-S-1 and 2 cribs was completed. Based on radioanalytical analyses and sediment characteristics of soil samples a good correlation was found between geological structures and directions of waste movement. It was concluded that similar field studies and analyses have application in defining the distribution and concentrations of radionuclides in the vadose zone beneath the 200 Areas.

Four soil column tests were performed to evaluate the capacity of the 216-5-20 (SL - 1&2) crib. These experiments indicated 13.5, 11.0, 5.6, and 5.7 column volumes before strontium-90 breakthrough. At the present discharge rate the average of these data, 8.4 column volumes would indicate an estimated life for the crib of 7.2 years. The solutions used in these experiments were composited samples of 300 Area waste and Redox Laboratory waste in ratios of 9:1. Cesium breakthrough from these columns required nearly ten times the throughput needed to achieve a strontium breakthrough.

Analytical Services

Chloride interfered with the determination of nitrate in water when the color-producing agent, 6 nitro - 1, 2, 4 phenyldisulforic acid, was used. Silver sulfate removed the interference. With silver present, however, ammonium hydroxide was preferred over the alkali bases for color development.

One lot of nine-ounce jars used for vegetation sample containers was found to contain 10^{-3} microcurie of K^{40} (approximately one gram of natural potassium) per jar. The usual value is less than 10^{-4} microcurie of K^{40}. If not accounted for, the higher background would result in a many-fold increase in the reported K^{40} content of vegetation. The error will be prevented by regularly determining the K^{40} background of a jar from each new lot.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Cerium and Promethium Recovery

Additional rare earth double sulfate precipitation experiments were conducted to determine precipitate volume, decontamination from other fission products, and effect of pH on cerium and promethium recovery yields. Using conditions described last month, the centrifuged precipitate volume was one per cent of the 1WW volume. Decontamination factors from ruthenium, cesium, and zirconium-niobium were 1100, 75, and 150, respectively. The high decontamination factor from ruthenium, if substantiated by liter scale runs and plant tests, should alleviate the problem of ruthenium evolution in subsequent cerium-rare earth separation. Varying the initial pH from a value of 0.12 to 1.0 did not affect recovery, which averaged about 96 per cent.

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Three resin column runs were made based on the Ames EDTA rare earth separation process. The object was to obtain detailed data on resin capacity, flow rates, etc., for plant design purposes and to attempt to increase flow rates beyond those used previously in order to decrease radiation damage to the resin. Mixtures of equal quantities of the adjacent rare earths, praseodymium and neodymium, were used in the experiments. The first run used established conventional conditions. The Pr-Nd mixture was absorbed on a short Dowex-50 column and then displaced a distance of two band lengths with dilute EDTA through a similar column in the copper form at a flow rate of 0.85 ml/min,cm^2. Excellent separation was obtained with over 65 per cent of each rare earth being recovered at purities greater than 99 per cent. The second run was made at an elevated temperature (80 to 90 C) and with a flow rate of 3.5 ml/min,cm^2. Gassing was troublesome, and the run was terminated by precipitation of an insoluble rare earth complex in the bed. The third run was made at room temperature with eluate of higher pH and with hydrogen ions co-adsorbed with copper on the elution column. These changes should reduce the probability of neodymium and praseodymium precipitation during elution at elevated temperatures. The flow rate was 4.0 ml/min,cm^2. Although separation was not quite as good as in the first run (due to the higher flow rate), the run was successful in demonstrating that the copper-hydrogen bed would retain the rare earth band behind it at the higher pH. Operation at a moderately elevated temperature should sharpen up the separation.

Fission Product Solvent Extraction Studies

The extraction of fission product strontium, cerium(III), and cesium from neutralized synthetic 1WW was studied as a function of pH using two extractants: 4 volume per cent tall oil in chloroform and 3 volume per cent di-2-ethylhexyl phosphoric acid (D2EHPA) in a TBP-Amsco solution. The D2EHPA experiments differed from those of earlier investigations in that the neutralized aqueous phase was a slurry rather than a solution. Approximately 50 per cent of the cerium present was extracted into the organic phase at pH 8 in the case of D2EHPA and at pH 9 with tall oil. The remainder was mostly in the aqueous phase precipitate, suggesting a solubilization of the fission products by the organic extractant. Maximum cerium extraction coefficients, E_a^o, between aqueous supernate and organic were about 10^3 with both extractants. The maximum strontium extraction coefficient was 97 with tall oil and 10.8 with D2EHPA. These results suggest that gross cerium (rare earth) and strontium recovery might be realized in fair yield by solvent extraction of a neutralized 1WW slurry, provided contacting equipment can handle such systems.

Fission Product Isolation and Packaging Prototype

The last equipment components (i.e., the Capper and Hopper-Crystallization assembly) packaging prototype are nearing completion in the shops and should be delivered during June. Initial integrated "cold" prototype studies on the recovery of cesium from cesium-zinc-ferrocyanide slurries are scheduled to begin during the latter part of June.

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The strike at the General Mills plant has been settled and work has resumed on the manipulator to be tested with the fission product prototype. Shipment on the manipulator is not expected before the first week in July.

During the month, the 321-A Building overhead crane system, which supports the General Mills manipulator and its carriage, was completed by Minor Construction. In addition to serving the fission product prototype, the crane system will be useful for the non-production fuel reprocessing studies and other studies conducted in the 321-A Building.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

The Determination of Acid in TBP Solutions

A direct non-aqueous titration method for determining the acidity of Purex organic samples containing uranium was developed. The acid sample is titrated in three milliliters of pure tributylphosphate with a standard 0.02 N solution of potassium methoxide in isopropyl alcohol. A standard glass electrode is used for "pH" measurements against a modified calomel reference electrode. The reference electrode was modified by providing a salt junction of a larger area consisting of a glass frit, and by substituting methyl alcohol saturated with potassium chloride for the usual aqueous salt bridge. The titrations are most conveniently run using a motor driven Gilmont micro buret and a chart recorder. Sample sizes down to 50 microliters are used. The breaks at the end-point are about 45 millivolts high, the titrations are accurate and they can be repeated with a standard deviation of at least ± 0.01 N or about ± 1.0 per cent for a 1.0 N sample. The method does not distinguish between the common mineral acids. Dibutyphosphate titrates as a strong acid while acetic acid does not titrate. Varying the concentration of uranium has no effect. Iron and aluminum would titrate as acids through hydrolysis, but their solubility in the Purex solvent is insignificant.

The method can be applied to the determination of the acidity of aqueous acid samples containing uranium using an alcohol - TBP - benzene solvent, but it appears to be no more precise nor convenient than the usual oxalate complexing method. In addition, iron and aluminum interfere.

EQUIPMENT AND MATERIALS

234-5 Cyclone Powder Trap

Miniature cyclone separators are being investigated as possible replacements for the primary off-gas filters used on the 234-5 Building calciners, fluorinators and chlorinators.

Various modifications of a mini-cyclone (1/2-inch diameter) were tested for removing entrained powder from air. Separation efficiencies ranging from 20 to 98 per cent were obtained for a five micron dispersed silica powder. The cyclones were operated at an entrance velocity of approximately 50 feet per second. Caking and bridging within the cyclones caused the poorer performance. Currently, methods to minimize or prevent bridging are being investigated.

HAPO Canned Motor Screw Pump

Testing of the HAPO canned motor screw pump was discontinued after 12,360 hours successful operation in water. The motor is being dismantled for inspection and wear measurements. The screw pump is a low head (up to 8 feet of water), high capacity pump capable of passing some particulate matter. It has been developed for possible use as a recirculation pump for dissolver solution. Since the pump employs process-solution lubricated bearings, special bearing materials would be required to permit its use in the corrosive media which might be encountered in the dissolver required for the non-production fuel reprocessing program.

Centrifugation Studies

Within the next year or two, several new centrifuge applications may develop at Hanford. Special critically safe centrifuges may be needed for the 234-5 program and the non-production fuel reprocessing program, while other centrifuge designs may be required to meet the specific needs of the fission product recovery program. Currently, a study is being made to determine the pilot plant centrifugation studies required and the pilot plant equipment needed to permit specification of design criteria for the production plant centrifuges.

Titanium Fabrication

Technical assistance was given to Technical Shops in the fabrication of a titanium bottom subassembly for the Redox L-3 concentrator loop. Some difficulties were encountered in getting good weld penetration, as indicated by radiographs of the completed welds. Since the difficulties are believed due to the inexperience of some of the craftsmen involved, a welder qualification program is being set up for titanium welding.

Hood Panel Mounting

Samples of new hood panel mounting methods have been submitted to 234-5 personnel for comment. The samples submitted incorporate "quick" panel replacement devices and gasket mounting techniques which eliminate sharp edges and grooves where plutonium powders can accumulate.

Plutonium Oxide Chlorinator

Screening tests of a large number of materials for possible use under conditions expected in the plutonium oxide chlorinator indicated promisingly low corrosion rates for Chlorimet-2, Inco 804, Ni-o-nel, nickel, Hastelloy B and Hastelloy C. Samples of these materials were exposed simultaneously to phosgene-air-water mixtures at 400, 500, and 600 C to compare their behavior under identical exposure conditions. All showed corrosion rates less than one mil/mo. at 400 and 500 C. Rates at 600 C ranged from 2.3 to 5.9 mils/mo. with nickel and Chlorimet-2 having the lowest rates.

Purex F-6 De-mister Pad

A sample of 11 mil titanium wire (exact type -- A40, A55, or A70 -- unknown) was exposed to the vapor phase over boiling 6 M HNO_3 to determine its suitability as de-mister pad packing in the Purex F-6 concentrator. A control sample of 20 mil 304-L stainless steel wire was exposed to the same environment. Both corroded at a rate of about 0.02 mil/mo. during a 200 hour exposure. The rate is somewhat higher than expected for titanium and may be due to flaking of an oxide coating present on the wire.

Corrosion of Carpenter 20 and Carpenter 20Cb in Nitric Acid

To determine their suitability for use in pump parts, corrosion rates for Carpenter 20 and Carpenter 20 Cb in boiling 65 per cent HNO_3 were determined. Both materials in the annealed condition corroded at about 0.7 mil/mo. during a 200 hour exposure. Sensitized Carpenter 20 corroded at about 20 mils/mo. and Carpenter 20 Cb at about 200 mils/mo. Cold working appears to have a beneficial effect on the corrosion resistance of Carpenter 20 Cb to nitric acid. Areas under metal-stamped sample numbers on the sensitized samples were attacked much less rapidly than the remainder of the samples.

PROCESS CONTROL DEVELOPMENT

UO_3 Plant Automation

The first phase of the calciner automation program was completed with plant installation of the steam programmer on K-calciner. This programmer controls the steaming cycles and the automatic setting of a fixed set-point on the feed-recorder-controller during start-up. Very satisfactory operation of K-calciner has resulted since the installation of this unit.

The construction and testing of the prototype control programmer for the complete automation of the calciners were completed this month. A few wiring and design changes were made to obtain the desired performance. For test purposes mockups of the three servo units were used which operate about 50 times faster than the rate at which the final units will operate. The programmer is presently being bench tested, with 50 simulated start-up and shutdowns occurring per day.

An "O" ring seal on one of the magnetic flowmeters at the UO_3 Plant failed after 725 hours of use on 100 per cent UNH. It is suspected that a Buna-N electrode seal was used in the unit rather than the specified Viton-A.

Polyvinyltoluene Scintillators

Further tests with terphenyl-in-polyvinyltoluene phosphor have been performed. Exposure to 30 per cent tributylphosphate in spray base reduced the phosphor thickness from 0.060-inch to 0.043-inch in 24 hours. After this test, the remaining crystal performed about as well as a new one when exposed to an alpha source in air. Neither erosion nor dissolution has apparent effect on the crystal performance. No reduction of phosphor thickness occurred in five

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days exposure to a solution of six molar nitric acid saturated with TBP. A slight surface tackiness exists, probably due to the TBP present. Tests are continuing to further evaluate the usefulness of this material for alpha counting.

pH Probe Installed in E-3 Purex

A pH probe designed as an integral part of a jumper has been installed in the E-3 tank at Purex. The unit appears to work satisfactorily and is being calibrated vs. laboratory pH values of samples of the tank contents.

NON-PRODUCTION FUELS REPROCESSING

Mechanical Head-End Studies

Shearing Unirradiated Uranium-Bearing Fuel Rods. Stainless-steel clad swaged UO_2 rods and stainless-steel clad uranium-10 w/o molybdenum alloy (U-Mo) rods were sheared under water to investigate the mechanical and particulate handling problems associated with these two major components of the power reactor fuels reprocessing program. Moderate shear forces (25,000 and 9,500 lb./sq.in. for U-Mo and UO_2, respectively) and minor end closures (less than 10 per cent) were observed in shearing. As was expected, the U-Mo cut clearly, with minimum fines generation, while up to 30 per cent of the UO_2 disintegrated to form a sludge in the bottom of the catch bucket. A small fraction of 10 to 20 micron-sized UO_2 particles were forced into suspension to color the water a muddy brown. On standing, they settled in less than 16 hours. The studies indicate that the shear auxiliaries (e.g., product receivers, bath filters) must be designed to handle the fines and slurries produced.

Sodium Reservoir Sawing. Inert-gas blanketed, water-submerged sawing of sodium potassium alloy (NaK) filled capsules was continued to conclusively demonstrate the success of this technique in eliminating NaK (or Na) reservoirs from the active sections of power reactor fuels. Loadings up to 48 grams of NaK (12 gm./capsule) were exposed in a single blade pass (24 gm. maximum instantaneous exposure) with two-inch maximum water submergence and a helium-purged hood atmosphere containing less than 5 per cent oxygen. The usual dense white cloud of oxide fume formed in the saw hood, but no fires or explosions occurred. The NaK exposure rate encountered in the above test is a factor of two greater than the rate contemplated during production cutting of the PRDC fuel rods.

Hydrogen was not detectable with a chromatograph on the saw hood after a cut of over 20 grams of NaK was made. The detection limit of the chromatograph is 0.2 per cent of H_2 in He.

Feed Preparation

Darex Laboratory Studies. Studies on the effect of dissolver solution composition on chloride removal showed that the terminal chloride concentration after prolonged boiling with concentrated HNO_3 increase with stainless steel concentration. High concentrations of stainless steel (>1.25 M) must be present to prevent attaining terminal chloride concentrations of 0.1 g/l. or less. The presence or absence of uranium had little effect on the terminal chloride concentration attainable.

Darex Pilot Plant. Ten stainless steel clad (10 mil wall thickness) metallic uranium core (3/4-inch OD) fuel elements were dissolved smoothly and completely in 1 M HCl, 6 M HNO_3 in about seven hours.

Chloride was removed from an 0.85 M stainless steel and 0.8 M U solution by sparging with NO_2-N_2O_4 and air. Chloride volatilized at the rate of 0.1 mole chloride per mole NO_2 added. Acid was produced at the rate of 0.7 mole H^+ per mole NO_2 added until the solution reached 6.1 M H^+, after which no additional increase was obtained. Terminal chloride concentration was 1 M compared with 0.2 M reported last month for solutions containing uranium but no stainless steel.

A Hastelloy F probe with a heat transfer surface has been installed in the Darex pilot plant dissolver for seven weeks. After 623 hours at low temperature and 244 hours at or near boiling the probe showed a sharp corrosion band 1/16-inch deep over an area 1/16-inch wide corresponding to the vapor-liquid interface. Generalized pitting to depths 1/16-inch was noted in an area surrounded by stagnant vapor. Areas exposed to liquid and vapor showed mild corrcsion similar to that previously reported for the Hastelloy F coupons exposed in Darex system.

A similar probe made of Haynes-25 showed comparatively little corrosion after six months in the Darex dissolver. Corrosion of Haynes 25 was most noticeable in areas sensitized by welding. No preferential attack was noted at the vapor-liquid interface.

Niflex Pilot Plant. Studies to date on the Niflex process have developed the following information:

1. The reaction with 304 stainless steel involves 0.6 mole of HNO_3 and three moles of HF per mole of stainless steel in a downdraft dissolver system.

2. Charge ratios, i.e., moles of fluoride per mole of stainless steel, above five are required for complete dissolution.

3. Dissolution of 304 stainless steel averages 10 mils per hour during the first hour of dissolution.

4. Approximately 0.1 mole of hydrogen was liberated per mole of stainless steel dissolved. Peak hydrogen evolution rate was 5×10^{-4} lb. mole/(hr)(sq.ft) of stainless steel.

5. Corrosion of Hastelloy F containment vessel was severe.

Sulfex Process

Studies of the effect of radiolysis on the rate of attack of fuel core materials by the Sulfex medium (dilute sulfuric acid) were extended to more highly irradiated uranium dioxide. It was found that uranium dioxide irradiated to a (calculated) exposure of 3000 MWD/T and cooled five months was attacked by boiling

4 M H_2SO_4 at a rate of only 0.02 per cent per hour. This corrosion rate is essentially identical to that found in earlier work with 500 MWD/T uranium dioxide cooled nine months, despite the fact that the measured radiation dose rate with the present material is greater by a factor of 7.5, and within a factor of probably two to three of that expected in the NPF program.

Sulfex Pilot Plant. Modification of the Niflex dissolver has been completed, and recalibration of the equipment is essentially completed. Preparations are under way to begin pilot runs of the Sulfex process.

Dissolution of U-Mo Alloy. Further studies on the dissolution of U-9 per cent Mo alloy in HNO_3-$Fe(NO_3)_3$ solutions were made. The maximum uranium concentration which can be achieved during dissolution without solids formation is dependent on the terminal HNO_3 concentration and increases from about 0.5 M at 0.5 M free acid to about 0.7 M at 2.0 M free acid. The acidity of the solutions at room temperature can be reduced to about -0.4 M free acid with Dibar without solids formation.

Preliminary attempts to identify the iron-molybdenum complex formed when molybdenum or U-Mo alloy is dissolved in HNO_3-$Fe(NO_3)_3$ involved adsorption of the complex on anion exchange resin. In the absence of uranium, iron and molybdenum were adsorbed on the resin in a mole ratio of one to six (Fe/Mo). Salts containing the group $(Fe(MoO_4)_6)^{-9}$ are reported in the literature. Data so far obtained with uranium present are confused due to analytical difficulties.

The dissolution rate of U-3 per cent Mo alloy in aluminum jacket removal solutions (10 per cent NaOH - 20 per cent $NaNO_3$) was found to be very low. During 30 minute exposures to the boiling solution, the average dissolution rate was about 0.00015 gm/(sq.cm.)(hr.). Thus, NaOH-$NaNO_3$ decladding followed by core dissolution in HNO_3-$Fe(NO_3)_3$ appears to be a satisfactory procedure for dissolving the aluminum clad U-Mo alloy fuel scheduled for reprocessing at HAPO.

Dissolution of Zircaloy-2. The dissolution of Zircaloy-2 in HNO_3-HF-$Al(NO_3)_3$ solutions was studied. Optimum nitric acid concentration, from a corrosion as well as a dissolution rate standpoint, appears to be in the range of one to three molar. In a 2 M HNO_3 - 1 M HF - 1 M $Al(NO_3)_3$ solution, Zircaloy-2 dissolution rates decreased from about 15 to 2.5 mils/hr. as dissolved zirconium concentration increased from zero to 0.25 M.

Solvent Extraction

Uranium-Molybdenum Alloy Feeds. Further mini-mixer-settler runs with feeds prepared by dissolution of U-3 per cent Mo alloy were made to study the effect of feed acidity and salting strength under simulated Redox solvent extraction conditions. As with Niflex and Darex feeds, increasing acidity resulted in reduced gross beta and gamma decontamination in the first cycle. With feeds at -0.3 M free acid (0.80 M U, 0.87 M Fe, 0.3 M Al), the gross beta and gamma decontamination were lower by factors of about 15 and 30, respectively, than obtained in control runs simulating current Redox feeds. Ruthenium contributed most of the radioactivity in the product streams. Changes in salting strength

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had much less effect on over-all decontamination than variations in acidity. Uranium and plutonium recovery was generally good (< 0.2 per cent loss) indicating successful oxidation of plutonium. Greater than 90 per cent of the neptunium present appeared in the product streams. Molybdenum concentration in the product streams was less than five ppm. parts uranium. Extraction of dichromate was not observed in these runs in contrast to observations during runs with high acid Darex and Niflex feeds. Aqueous raffinates were stable toward precipitation if feed acidity was -0.3 M or higher.

Alternate Redox Solvents

It has been previously reported that diethers in which the two ether oxygens are separated by 4 to 6-CH_2-groups offer certain attractions over hexone as a Redox Plant solvent. Specifically, they have significantly higher flash points than hexone and exhibit considerably better resistance toward nitric acid.

Recent work indicates these compounds may offer some advantage over hexone from the standpoint of fission product decontamination, as well. Batch contacts were made comparing uranium, zirconium-niobium, and ruthenium distribution from identical aqueous solutions into hexone and nine diethers. With a dilute uranium solution containing 1.5 M aluminum nitrate and adjusted to 0.2 M acid deficient, uranium distribution ratios ranged from about unity with methoxy-butoxy pentane to 27 with dimethoxypentane, vice about 4 for hexone. Ruthenium distribution ratios ranged from 0.0037 with methoxybutoxy pentane to 0.019 with dimethoxy pentane, vice 0.011 with hexone. Zirconium-niobium distribution ratios varied in a random fashion but were roughly bracketed by the values of 4.1×10^{-5} and 5.8×10^{-4} obtained for hexone with two different feed batches. With an acidified dilute uranium feed containing 1.5 M aluminum nitrate, and 0.2 M nitric acid, uranium distributions ranged from 2 for methoxybutoxy pentane to 48 for dimethoxy pentane, vice 15 to 19 for hexone. Ruthenium distributions ranged from 0.12 for methoxybutoxy pentane to 2.4 for dimethoxy hexane, vice 0.6 to 0.7 for hexone. Zirconium-niobium distributions were again scattered, ranging from 0.016 for methoxybutoxy pentane to 0.5 for dimethoxy pentane, vice 0.05 to 0.07 for hexone.

Distribution ratios for plutonium(IV) and plutonium(VI) have not yet been measured. If these prove operable, it is planned to evaluate via miniature mixer-settler studies the decontamination potential for such solvents in an acid first cycle followed by one or more acid-deficient cycles.

Zirflex Waste Mobility. Flow properties of neutralized Zirflex waste were determined in semi-works scale equipment (5-gallon head tank and 1/2-inch flow tube). The solids settled rapidly to 20 per cent of the total volume. Medium agitation was required to keep the solids suspended. The slurry was transported through the flow tube without difficulty when the flow was turbulent (Reynolds number greater than 2500).

Materials of Construction

Welding of Hastelloy F. A series of Hastelloy F weldments (welded with Hastelloy F filler wire) were annealed for one hour at 2100 F and water quenched. The weldments were then given an additional one-hour anneal at temperatures ranging from 1400 to 1900 F. In every case, the additional heat treatment reduced corrosion resistance of the weld metal to boiling 1 M HNO_3 - 1 M HF. Samples annealed at 1600 and 1700 F showed, also, severe intergranular attack on the base metal.

Hastelloy F weldments prepared by electron beam welding and by metal arc welding in a gloved box purged with helium showed the same degree of preferential weld metal attack in HNO_3-HF solutions as those welded by the usual tungsten-inert gas techniques.

Attempts to determine composition of the segregated phase in Hastelloy F weld metal by means of the microarc emission spectrograph were not successful.

Sulfex. Welded and annealed Haynes 25 tubing corroded at rates about the same as those previously observed for Hastelloy F in H_2SO_4 and H_2SO_4-stainless steel solutions. Preferential weld metal attack occurred in the H_2SO_4-stainless steel solutions.

Darex. Hastelloy F samples were exposed to 2 M HCl-5M HNO_3 at boiling and at 25 C with and without an air sparge. Severe interface attack occurred in the absence of boiling or air sparge. No observable interface attack occurred when the solution was boiling and air sparged.

HNO_3-$Fe(NO_3)_3$ Systems. Both Ni-o-nel and Hastelloy F were corroded intergranularly in 5 M HNO_3 - 1 M $Fe(NO_3)_3$. Base metal corrosion rates were relatively high (10-12 mils/mo.) for both alloys in this solution at boiling. The rates were reduced by decreasing either the ferric nitrate or the nitric acid concentration. These observations point to the need for controlled addition of one or both of these reagents during the dissolution of U-Mo alloys. Ni-o-nel weld metal showed no preferential attack in this system.

Process Control Development

Precision Level Measurements. Preparation of the equipment for precision level measurements on tank T-4 is complete. The tank interior has been cleaned, flushed, and drained dry. A sensitive electronic relay connected to a gaging rod will be used as an accuracy standard to determine the height of liquid above the bottom of the tank. A hand operated lead-screw drive moves the gaging rod up and down. Two 150-inch precision manometers are used to read the tank level, and one standard 50-inch manometer is used to read the specific gravity. A stainless steel 43-gallon heavy water drum with dome ends is used for the solution weigh-in measurements. Shake-down tests of the level measurement equipment are now under way.

Boron Monitor. Flow tests on the boron monitor are complete. The unit exhibits pressure drop characteristics equivalent to 20 feet of 2-inch schedule 40 pipe. The monitor will handle approximately three times its design flow rate of 50 gpm. Fabrication of the unit is now under way in the technical shops.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Molten Salt Cycling of UO_2

Preliminary experiments were performed with aged, slightly irradiated UO_2 to learn of fission product behavior in the cycling of UO_2 through a NaCl-KCl molten salt phase by dissolution as UO_2Cl_2 with chlorine and reprecipitation as UO_2 with zinc. Although activity of the samples was low, Zr-Nb and Cs-Ba appear to have dissolved and remained in the salt phase throughout the experiment. Ru-Rh and Ce-Pr appeared in the salt phase, but on reduction with zinc their activities were reduced ten-fold. It is not known whether they precipitated with the oxide or whether they were reduced by the zinc. Fission product behavior is currently being studied using a 10 to 15 gram sample of slightly enriched uranium exposed to 900 MWD/T and cooled 150 days.

Further studies have shown that (1) U_3O_8 reacts almost completely with molten NaCl-KCl in two hours to yield what is apparently UO_2Cl_2, (2) UO_3 dissolves readily in the same salt under the influence of HCl to yield UO_2Cl_2, and (3) UO_2 reacts with chlorine in NaCl-KCl eutectic at 500 C giving the characteristic UO_2Cl_2 solution; with HCl under the same condition UCl_4 if formed. Thus, by a suitable choice of halogenating agents it is possible to exercise some control over the dissolution characteristics of the various uranium oxides, a fact which may have process significance.

An interesting observation was the very slow rate of attack of Zircaloy-2 by chlorine in molten NaCl-KCl at 700 C. A freshly pickled piece suffered a weight loss of only 2.7 per cent in two hours under these conditions.

Application of Molten Salt Cycling of UO_2 to Thorium Oxide Processing

A separation factor of 500 for uranium from thorium was obtained in the dissolution of a 5:1 mixture of ThO_2 and UO_2 by chlorination in molten NaCl-KCl. The thorium was only slightly dissolved during the reaction.

$AlCl_3$-KCl System

The results of a very carefully done study of the distribution of uranium between molten aluminum and $AlCl_3$-KCl phases in sealed evacuated quartz ampules agree very well with experiments performed in open tubes. It has been definitely shown, however, that the aluminum chloride content of the salt phase as determined by aluminum analysis is two to six per cent high because of the presence of aluminum oxide which is soluble in hydrochloric acid, and thus analyzes as $AlCl_3$. The origin of the soluble alumina is the reaction of aluminum metal with silica or possibly air oxidation. This bias results in an uncertainty of the curve formed by plotting actinide distribution as a function of $AlCl_3$/KCl in the vicinity of a ratio of unity where the distribution maximizes. At other values where the function is less sensitive the ratio, the effect is inconsequential.

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The separation factors for uranium and plutonium as a function of the $AlCl_3/KCl$ ratio are, respectively, 29, 38, 47, 58, 75, and 102 at ratios of 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9.

High Temperature Spectrophotometry

The visible and ultraviolet absorption spectrum of UO_2Cl_2 in NaCl-KCl eutectic shows strong absorption at all wave lengths except in the vicinity of 650 to 750 mu where strong transmission occurs. With increasing temperature from 650 C to 850 C a decrease in absorption and shift of the transmission peak to longer wave lengths is observed. What appears to be fine structure is also observed in the peak region. The absorption minimum coincides with that of the spectrum of aqueous uranyl chloride solutions.

Phthalocyanine Compounds

Compounds formed by the action of phthalonitrile and powdered metals have remarkable stability at high temperatures and in rigorous environments. The copper phthalocyanine, for example, retains its identity in molten alkali and sublimes under reduced pressure at 500 C. Because of possible useful properties, an attempt was made to synthesize the uranium compound by reacting powdered uranium (produced via the hydride route) with phthalonitrile at 220 C. A purple compound soluble in concentrated sulfuric acid, but yielding a blue precipitate on dilution was obtained. Further characterization of the product, which is probably uranium phthalocyanine, will be made.

WASTE FIXATION

Radiant Heat Spray Calcination

The first runs with a neutralized 1WW waste were carried out during the month. The slurries used corresponded to caustic neutralization of a high acid 1WW and consisted of about 7 M $NaNO_3$ with a suspension of the hydrous oxides of iron, aluminum, chromium, and nickel. A Sigma finger pump was used to move the slurry, and the atomizing nozzle was equipped with a clean-out needle. No difficulty was encountered in pumping or atomizing the slurry, but the sodium nitrate coated the walls of the calciner and eventually terminated the operation. The fact that sodium nitrate melts at about 300 C but does not decompose appreciably at temperatures up to 700 to 800 C also makes calcination of neutralized waste in paddle trough calciners or fluidized beds virtually impossible.

Small scale experiments were then carried out to test several ways of destroying nitrate chemically. Addition of sugar was found to work best. A mixture of simulated neutralized waste and sugar was stable for days at 80 C, but reacted readily at 220 C. A run was accordingly made in the eight-inch unit with a slurry feed containing 250 g/l sugar. Operation was very smooth, and there was little or no build-up of dust on the walls. The product powder (predominantly Na_2CO_3) had a bulk density of 0.85 gm/cc and fused at 860 C to a compact glassy melt with a density of 2.3 gm/cc. Residual nitrate was very low ($\leq$0.0015 per cent). Presence of some ammonia in the off-gas indicates that over reduction of some of the nitrogen occurred, and that it may be possible to decrease the quantity of sugar.

Sulfate analyses have been obtained on the products of earlier acid feed runs. In the absence of additives, little or no sulfate was lost and the product was 50 weight per cent sulfate. With phosphate addition, some sulfate was displaced, yielding 33 weight per cent sulfate. Addition of sugar to the feed decreased this to 15 per cent, implying chemical reduction of a portion of the sulfate.

Mineral Reactions

The possibility of demonstrating the decontamination of low-level wastes by a prototype installation on the D-2 Redox stream was studied further. Experiments were performed to determine the source of the insoluble materials found in samples of D-2 waste. Four samples were found to contain 2.4, 4.5, 7.0, and 5.9 ppm acid-insoluble solids. This solid appeared to be an effective scavenger for radioactive material in the waste. The solids are probably introduced with raw water used to cool the waste but may, in part, originate in entrained material from the evaporator. It was found that an entrainment factor of 10^{-4} resulted in an aluminum hydroxide precipitate in the D-2 waste that scavenged 80 per cent of the radioactive material; part of the observed solid material is believed to originate by this entrainment.

Studies were continued to determine the feasibility of using mineral reactions to decontaminate condensate streams which may originate from fuels reprocessing plants and waste concentrating and fixation facilities. Economic studies were continued to determine the cost added to waste disposal processes using these reactions. Preliminary scoping of a facility for the scale-up studying of the mineral reactions was initiated so that the required capital investment can be estimated.

Fluidized Bed Ion-Exchange Studies

Eighteen breakthrough runs were made in the 4-inch-diameter by 6-foot-long glass column using Cs-134 as a tracer. Preliminary results indicate a possibility of satisfactory operation at bed expansions of ten per cent or less, corresponding to flow rates of 0.6 gal./(min.)(sq.ft.) or less. The values for holdback (a measure of the deviation from piston flow) obtained at upflow rates 0.6, 1.1, 1.5, 2.4, and 3.6 gal./(min.)(sq.ft.) were, respectively, 0, 10, 40, 40, and 100 per cent higher than at the corresponding downflow rates.

Studies leading to values of transfer unit heights under the same variations in flow conditions have been initiated.

Dissolver Off-Gas Analysis System

A dessicant is needed in the Redox off-gas sampling system to reduce the relative humidity to 10 per cent without removing any ammonia. Drierite ($CaSO_4$) will be tested, since indications are that it will remove water without absorbing ammonia. Quicklime, slakelime, soda lime (mixed CaO and NaOH), and sodium or potassium hydroxide are other candidates, but they cannot be easily reactivated.

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BIOLOGY AND MEDICINE - 6000 PROGRAM

Geology and Hydrology

The general pattern of directions of flow of the Columbia River as it deposited the near-surface part of the fluviatile sediments has been determined from examination of the irregular stream bedding in many open pits over a period of years. This disclosed, in the vicinity of the Separations areas, flow directions comparable to the flow directions of the river as it incised its channels into the top of Ringold formation. This implies regional controls to those river flow directions (Gable Butte and Gable Mountain) and suggests that the intervening sediments, between the top of the Ringold and the base of the pits, were deposited by streams flowing in similar directions. Inasmuch as the deposits from flowing streams are usually both anisotropic and heterogeneous in ways directly related to the directions of the river flow, determination of those directions during deposition and later erosion of both the Ringold and Recent fluviatile sediments is valuable in the interpretation of waste behavior and ground water flow data. Gross local divergences between the indicated flow patterns in the top of the Ringold formation and in the fluviatile sediments appear due to local structural differences, such as the greater or lesser ease of erodability of certain beds or facies, and the effect of those on subsequent deposition.

An analytical and numerical iteration process were developed to evaluate the mathematical representation of unsaturated flow beneath a crib. These techniques were tested by comparison with measured data obtained from a laboratory-scale model of a crib. The results from the numerical method differed from the measured flow rates by from 0.4 per cent to 4.0 per cent, and the results from the analytical method differed from the measured flow rates by from 0.6 per cent to 63 per cent. It is believed that the results from the analytical method would compare better with those from a somewhat larger model in which the boundary conditions chosen for the analytical solution were more applicable.

Further laboratory experiments were conducted to test the centrifuge technique for estimating soil drainage. The average of 16 measurements of the moisture content of 10-gram samples of soil subjected to 500 gravities for one hour was 16.7 per cent by weight. That of 16 measurements of the moisture content of 5-gram samples of soil subjected to 1000 gravities for 0.25 hour was 16.9 per cent by weight. This agreement reaffirms the applicability of the gravity-time-drainage relationship:

$$N_1^2 T_1 = N_2^2 T_2,$$

when the bed thickness - gravity relationship is:

$$N_1 H_1 = N_2 H_2$$

Failure to recognize the importance of the bed thickness in earlier experiments led to the assumption that the centrifuge method did not give consistent results.

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Soil Chemistry and Geochemistry

The influence of temperature, flow rate, salt concentration, and pH on the adsorption of cesium from solution by clinoptilolite was studied for the low pH range. Under acid conditions the influence of those variables is much less pronounced than was observed for the high pH range. The Cs^+ exchange capacity of clinoptilolite was found to be about 34 me per 100 g from 3 M $NaNO_3$ solution. It remains essentially unchanged over the temperature range from 25 to 60 C and with column flow rates from 1700 to 5000 gal/ft^2/day. Under these same conditions clinoptilolite has a Cs^+ exchange capacity of about 75 from 1 M $NaNO_3$ solutions. These capacities differed little over the pH range from 3 to 7. The sensitivity of the clinoptilolite capacity to conditions of the system at pH greater than 11 is believed to be caused by an alkaline reaction with the silica matrix of the mineral.

Adsorption of ionic cerium by soil occurs from pH 1.2 to 5.2. Evidence was found of cerous hydroxide precipitation starting at pH 4.6 and essentially complete at pH 5.2. This precipitation occurs at concentrations as low as 10^{-11} M. In low-salt systems the precipitate peptizes in the pH range from 9.8 to 12.2; peptization is prevented by 0.35 M sodium salt.

Ground Waste Investigations

A study was initiated to investigate problems associated with ground disposal of wastes from various of the new-type fuel elements being considered. Initial work was planned to study nickel-coated fuels.

Strontium breakthrough tests were completed on two 47-foot soil columns. These experiments were primarily intended to determine if the observed effect of column length continued over a wide range of column sizes or if the effect approached a maximum for some particular column length. It was found that the slope of the breakthrough curve continued to steepen with increasing column length even in these very long columns. Since these columns were long in relation to the theorectical plate height or distance required to achieve equilibrium, it can be assumed that the increase in slope continues in still longer soil columns.

A 2-foot square field experimental crib facility was placed in operation, receiving a solution of calcium nitrate spiked with strontium-85. Ground water lies at somewhat less than fifteen feet. The facility is surrounded by seven shallow wells driven into the ground water and used to monitor the behavior of the solution in the ground. A breakthrough of nitrate into these wells was detected when between 1300 and 2300 gallons of solution had been discharged. The first radiostrontium breakthrough was detected after disposal of less than 5000 gallons. After 8400 gallons had been discharged to the site, the radiostrontium concentration in samples from the wells ranged up to 50 per cent of that in the influent. This experiment will help define the application of laboratory soil column experiments to predict the breakthrough of radioisotopes into the ground water beneath field disposal sites. On the basis of a laboratory column test of the same solution and with soil from the same site, the model crib has an effective soil volume more than ten times that calculated from the area of the crib

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and the depth of the soil profile. This factor must not be considered directly applicable to larger facilities because it includes the effect of some forces, such as capillary action, which cannot be scaled.

Field Apparatus Development

Refraction seismic studies gave additional strong support to the usefulness of this method for determining depth to basalt. In tests carried out using a geophone and an improved locally assembled interval timer additional accurate measurements were made. With the more versatile well-developed equipment offered by geophysical equipment firms, excellent results should be more rapidly obtained.

Additional tests performed with the repaired in-well permeability packer again suggested that water pumped into the packer cavity was either by-passing the seal elements or moving rapidly along the casing, precluding measurement of in-place permeability. Although remedial measures are available, their complexity and expense would greatly reduce the value of the method.

Rupture Monitoring and Rupture Debris Characterization

Previous characterization of particle sizes of uranium oxide during the failure of fuel elements in autoclave tests indicated that about 50 per cent of this material may be expected to be retained in the reactor effluent retention basins. In contrast, an evaluation of an earlier analysis of effluent retention basin sludge (amount and concentration of fission products in 100-D basin) indicated that about 10 per cent of the more soluble fission products entering the basin had been retained as sedimented sludge. Although data are meager, it is suggested that the assumption of zero efficiency for permanent retention by the basins is a satisfactory approximation when evaluating the significance of rupture debris in the Columbia River.

Micromeritics

Characterization of particles in the 234-5 Building ventilation exhaust air was essentially completed. Plutonium or compounds of plutonium were present almost entirely as discreet particles less than one micron in diameter, if it is assumed that the particles are spherical in this size range. Fifty per cent of the alpha emissions originated from particles with diameters greater than 0.57 micron and less than 0.98 micron. The results were substantiated through nuclear track stripping film techniques and cascade impactor sample analysis. Of considerable interest and significance was the observation that virtually no alpha particle activity associated with the inert dust loading of the exhaust air. The inert dust was determined to be largely Fe_2O_3 with a small amount of iron present. The data strongly suggest that corrosion of clean metal surfaces is occurring downstream of the high efficiency filters even after these surfaces have been several years in contact with significant quantities of particles of plutonium or its compounds.

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The felt disc filter designed as a final filter for removing the small particles from fuel element cutting operations showed good retention and capacity when tested in the Radiometallurgy Laboratory. The filter was used downstream from a pre-filter recommended earlier.

Radioisotopes in Reactor Cooling Water

Eu^{152} (13 y half life) was identified as the major long lived rare earth radioisotope present on the film in a reactor pigtail which was removed after nearly 15 years operation in B reactor. Several days after reactor shutdown it is second only to Zn^{65} in activity and more important than Zn^{65} with respect to gamma dose rate.

Comparative electrophoretic mobility studies indicate that the As^{76} in reactor effluent water as arsenate exists as an equilibrium mixture of $H_2AsO_4^-$ and $HAsO_4^=$ ions. The non mobile fraction of the As^{76} activity is probably unionized arsenious acid. The relative amounts of As^{76} as arsenate and arsenite varies from sample to sample perhaps due to slow changes occurring prior to analysis.

Analysis of the reactor effluent water off-gas released through piping vents verified that Xe^{137} was lost from the reactor effluent water as would be predicted from the measured loss of Kr^{89}. The ratio of the daughter products Sr^{89}/Cs^{137} was found to be 210 as compared with a calculated value of 203.

A permanent multiplier phototube mounting arrangement for a five-inch diameter three-inch thick sodium iodide scintillation crystal was completed which gave a resolution of 8.5 per cent for Cs^{137}. This was accomplished by using four two-inch 6655A RCA phototubes. A single five-inch phototube gave only 11 per cent resolution. This improved resolution increases the sensitivity of the crystal and greatly increases its utility for counting radioisotope mixtures.

Analytical Services

Two-hundred microgram plutonium sources were prepared for Meteorology by direct evaporation onto slowly rotating aluminum cone frusta. Prolonged heating under infrared lamps and coating with Krylon gave adherent plutonium.

L. P. Bupp

Manager,
Chemical Research & Development

LP Bupp:bp

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ORGANIZATION AND PERSONNEL

J. C. Langford, Chemist II, was transferred to the Chemical Processing Department from the Analytical Laboratories Operation.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
S. Stoller	5/4/	Vitro Corporation of America New York, New York	Non-Production Fuels Reprocessing	RJ Sloat	Yes
H. Eyring	5/6/	University of Utah Salt Lake City, Utah	Consultant	LP Bupp OF Hill RE Burns RF Maness WH Reas	Yes
W. Alter R. Sironen	5/7-8/	Vallecitos Atomic Lab. Pleasanton, California	Discuss radiochemical methods of analysis.	LP Bupp RJ Brouns FP Brauer WH Reas JL Ryan MT Walling	Yes
A. Matheson	5/11/	Sylvania-Corning New York, New York	Power Reactor Fuels Reprocessing	LP Bupp OF Hill	Yes
D. T. Galm	5/11/	Curtiss-Wright Corp. Quehanna, Pennsylvania	Discuss sampling of Purex wastes.	RL Moore KH Hammill HH Van Tuyl	Yes
W. Z. Friend	5/12/	International Nickel Niagara Falls, New York	Discuss materials of construction.	RE Burns RF Maness	No
C. C. Gamertsfelder	5/15/	Aircraft Nuclear Propulsion Cincinnati, Ohio	Discuss fission product release studies.	CE Linderoth RK Hilliard	No

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
J. O. Blomeke J. T. Roberts M. E. Whatley	5/14-15/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss waste treatment research and radiant heat spray calcination.	LP Bupp RL Moore GB Barton BM Johnson RT Allemann WH Reas OF Hill CE Linderoth LC Schwendiman DW Pearce	Yes
F. J. Leitz	5/19/	APED San Jose, California	Discuss pyroprocessing.	RH Moore	No
H. Susskind F. Blankenship	5/21/	Brookhaven National Lab. Upton, LI, New York Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss pyroprocesses.	RH Moore WL Lyon RL Moore	Yes
M. A. DeSesa S. Cseplo J. Cavendish	5/26/	National Lead Co. of Ohio Cincinnati, Ohio	U-Zr Problems.	AM Platt	Yes
M. A. DeSesa	5/26-27/	National Lead Co. of Ohio Cincinnati, Ohio	Discuss radiant heat spray calcination.	RL Moore BM Johnson RT Allemann WH Reas	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. C. Schwendiman	4/29-30/	Eurochemic Mol, Belgium	Consult in Health Physics work and in-line monitoring	E Haefner EL Nicholson HH Moeken	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	5/4/	Washington State Univ. Pullman, Washington	Present talk on low background counting techniques and gamma-ray spectrometry.		No
J. R. Raymond	5/12-13/	Humble Oil Company Houston, Texas	Discuss in-well measurements and techniques	J Rike F Faegin	No
	5/14-15/	International Petroleum Exposition Tulsa, Oklahoma	View equipment related to well drilling.		No
U. L. Upson	5/18-21/	Instrument Society of America Houston, Texas	Attend Meeting.		No
L. L. Burger	5/19-20/	University of Washington Seattle, Washington	Technical consultation on solvent extraction.	AL Babb	No
E. B. Street	5/18-21/	American Society for Testing Materials Los Angeles, Calif.	Attend Meeting.		No
	5/22/	Atomics International Canoga Park, California	Discuss spectrometry.	RT Keen	No

A. ORGANIZATION AND PERSONNEL

No significant organization changes occurred during the month.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Radioiodine Contamination

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

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

Columbia River Contamination

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

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

Samples of aquatic organisms were collected at the mouth of the Columbia River and along the Oregon and Washington coasts during the later part of April. Analyses of the radioisotopic content of this material are now in progress.

A linear relationship appears to exist between the time salmon fingerlings are exposed to a suspension of C. columnaris and time required for death. These data will be extended to include a relationship of a number of organisms and time of death so that testing for virulent strains may be more precise.

As a step in obtaining mutation rates in C. columnaris susceptibility of the organism to antibiotics was tested. Of those tested aureomycin and erythrocin were most effective; terramycin, distrycin, achromycin, and chloromycetim were intermediate; and sulfanilamide and streptomycin were lease effective. Mutation to antibiotic resistance will be evaluated to determine the mutational stability of the organism after exposure to ionizing radiation.

Fallout Contamination

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

Sample Type	µc/g wet materials Average	Trend Factor
Bone	6×10^{-5}	-
Feces	3×10^{-5}	-2
Liver	8×10^{-6}	-
Muscle	5×10^{-6}	-

Effect of Reactor Effluent on Aquatic Organisms

No monitoring of reactor effluent was carried out during the month following a shut-down of the 100-KE reactor. Equipment was in place for a new test at the end of the month, however, and a supply of fingerling-size trout was obtained from the University of Washington.

Population Dynamics

The annual nesting survey of Canada geese was completed. Hatching occurred slightly later than usual, probably because of colder temperatures. Fertility of adults was again 98 per cent. Nests visited weekly had a greater desertion and destruction rate than those visited but once.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Strontium

Four groups of rainbow trout were acclimatized for a study of radiation damage from Sr^{90}-Y^{90} to be administered via intramuscular injection. This experiment will start the first of next month.

No deviation from the pre-exposure hematological values was noted during the first three months in miniature swine fed 1, 5 and 25 µc Sr^{90} daily.

Two 75-Kg miniature swine (adults) were prepared as standards for calibrating the large animal monitor by injecting them with radiostrontium and then sacrificing and embalming them 24 hours later. One animal received 200 µc Sr^{85} intravenously and the other 1,000 µc $Sr^{90}Y^{90}$ (equilibrium mixture) by the same route. On the basis of preliminary tests, it appears we will not be able to detect body burdens below 25 µc of Sr^{90} even during reactor shutdown.

Bean plants grown in nutrient solutions containing widely differing ratios of strontium and calcium contained essentially the same ratio of these two ions in the whole plant as in the nutrient solution. There was some evidence of discrimination within the plant with a differential retention during transport to leaves. Roots had a higher Sr/Ca ratio than found in leaves with stems intermediate. At the lowest nutrient ratios of Sr/Ca there was a slight suggestion of preferential uptake of Sr over Ca.

Iodine

A second ewe fed 1.5 μc of I^{131} daily for the past four and one half years (after being born to and weaned from a dam on the same radioiodine regimen) manifested a thyroid tumor at autopsy. The thyroid tissue of both animals was hyperplastic and the adenomas arose in multiple sites. The histologic pattern was suggestive of a response of a gland to external stimulation, with the hyperplasia in certain areas going to neoplasia. We assume without confirmation that the external stimulation of the thyroid probably stems from an increase of thyroid-stimulating hormone (TSH) of the pituitary. (It appears there may be a tumorigenic optimum daily level of radioiodine which causes a very mild hypothyroidism leading to increased TSH production. This in turn acts on a slightly damaged gland which responds with hyperplasia.)

Cesium

Having previously found that increasing the potassium concentration in the nutrient solution 100 fold only halved uptake of Cs^{137}, a similar test was made using Rb^{86} in place of Cs^{137}. Increasing potassium 100 fold reduced plant concentration of Rb^{86} five to tenfold with a concurrent increase of 2 to 3 in potassium concentration. This suggests that, while uptake of Cs and K are nearly independent, there is a partial interaction of K on Rb. Neither Rb nor Cs appear to be ideal tracers for K in that the observed ratio (Rb/K)plant/(Rb/K) substrate is not constant.

Plutonium

Complete hematological data were obtained in rats at intervals from one hour to 20 days following injection of 6 μc Pu^{239}, 500 r x-ray, and combined plutonium and x-ray treatment. Depression of the hemoglobin, hematocrit and erythrocyte counts was most marked in animals receiving the combined treatment. The decrease in lymphocyte and total leukocyte counts occurred earlier and with greater severity following x-irradiation than following plutonium injection. Recovery, however, was apparent only in those animals receiving x-ray treatment only. Recovery of the depressed neutrophil count also occurred in the x-ray only animals, but not in those which received plutonium. Rats which were injected with 1 μc of plutonium and subsequently subjected to 100 r x-ray per week have now accumulated a total of 1300 r without obvious differences from animals receiving the x-radiation only.

Further data were obtained on the efficacy of large oral doses of DTPA in removing freshly deposited plutonium from rats. DTPA was administered at a 11 mM/kg dose at pH's varying from 3.4 to 7 and with Ca added as calcium gluconate or incorporated as the DTPA salt. Skeletal retention was reduced approximately 8 fold and liver

retention approximately 20 fold by all treatments. All treatments resulted in severe diarrhea, but animals were mostly back to normal within 3 days except for the treatment at pH 3.4 which proved fatal to 6 out of 7 animals. Two out of 7 animals died as a result of pH 7 treatment with combined DTPA and calcium gluconate. The least toxic treatment and the only treatment which resulted in no weight loss over a 5-day period was that at pH 5 where the material administered has the composition $CaH_{1.4}Na_{1.6}DTPA$.

Radioactive Particles

Additional mice were killed 500 to 600 days after inhalation of $Pu^{239}O_2$ and $Sr^{90}SO_4$. Gross pathology included several lymphomas, cystic liver, and hemorragic lymph nodes, but no marked lung pathology.

Five dogs inhaling plutonium oxide are being monitored weekly with the whole-body dog monitor. From the second to the sixth week after exposure the lung retention was exponential with a half-life of about six weeks.

Six hundred and twenty mice were exposed to different aerosol concentrations of $Pu^{239}O_2$ to determine the acute lethal dose for inhaled plutonium.

Gastrointestinal Radiation Injury

A method has been developed to determine absorption from the gastrointestinal tract in situ under controlled conditions. The apparatus provides a constant flow of perfusate through a section of the intestine at a constant temperature and constant intraluminal pressure. While experiments have thus far been preliminary for the purpose of developing and exploring the potentialities of the procedure, evidence was obtained for an 80% reduction in glucose absorption 3 days after x-irradiation (1500 r) of the exteriorized intestine. This method should prove widely applicable in studies of radioisotope absorption as influenced by a variety of physiological or nutritional factors.

Microbiological Studies

Fixation of yeast cells in OsO_4 produces material which sections well but which does not allow as good differentiation of cellular structure as does fixation in $KMnO_4$. Cells fixed in $KMnO_4$, sectioned, and examined under the electron microscope show the cell wall as a vesicular structure and a central membrane typical of a nuclear membrane. Structures within the nuclear membrane are suggestive of chromosomes but their positive identification will have to await tests with tritiated thymidine.

Adding erioglaucine to yeast cell suspensions during irradiation did not change the frequency of inviable cells. Erioglaucine was used in concentrations

similar to those used with cytochrome c which produced a 20 per cent reduction of killing.

The cytochrome c oxidase was inactive in cytochrome deficient yeast strains whereas normal strains had a very active oxidase.

R. Thompson

BIOLOGY OPERATION

C. OFF-SITE VISITS AND HAPO VISITORS

Name	Dates of Visits	Company or Organization Represented/Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Bldgs.
VISITS TO HANFORD WORKS						
Tri-City Physicians	5/6		Tour	Kornberg, Warner Palmer, Bustad, Bair, Davis, Foster	No	100-F, Biology
Dr. Grace Howard	5/8	U of Wash. Seattle	Taxonomic studies.	Pendleton	No	100-F, 146
Dr. R. Daubenmire	5/18	WSC, Pullman	Soil sampling.	Pendleton	No	" "
Dr. CG Gamertsfelder	5/14	ANP, GE, Cincinnati	Inhalation studies.	Kornberg	No	100-F, Biol.
A. Gartin and A. Neale	5/28	Washington Pollution Control Commission, Olympia	Discuss waste disposal problems.	Foster	No	100-F, 146
VISITS TO OTHER INSTALLATIONS						
WJ Clarke	5/7	WSC, Pullman	Lecture Radiotoxicology class	Klavano	No	
LK Bustad	5/11-13	ARCO, Idaho Falls	Mtg. of ANP Human Factors Working Group	Seigneur	No	
RC Pendleton	5/12	WSC, Pullman	Comparison of herbarium specimens	Ownby	No	
RF Foster	5/12	WSC, Pullman	Present seminar.	-	No	
VH Smith	5/16-23	Montefiore Hosp., NY	Discuss research	Harry Kroll	No	
		Pittsburgh, Pa.	Present paper	Radiation Research Soc.	No	
LA Temple	5/18-23	Pittsburgh, Pa.	Present paper	Radiation Research Soc.	No	
		USPH laboratory	Discuss research	Dr. Cember	No	
		New York Univ.	" "	Dr. Laskin		
HA Kornberg	5/23-28	Rockefeller Inst. NY	NAS meeting	Shields Warren	No	
RC Pendleton	5/27	WSC, Pullman	Identification of plants	Ownby	No	
PA Olson	5/27-28	U of Wash. Seattle	Pick up fish	Donaldson	No	

D. Lectures

a. Papers presented at Meetings

L. A. Temple, 5/18/59, "Tumorigenicity of intratracheally injected radioactive particles in mice," Radiation Research Society, Pittsburgh, Pa.

V. H. Smith, 5/18/59, "Removal of internally deposited plutonium," Radiation Research Society, Pittsburgh, Pennsylvania.

b. Off-Site Seminars

W. J. Clarke, 5/7/59, "Radiotoxicology," Class in Veterinary Toxicology, WSC, Pullman, Washington.

V. G. Horstman, 5/19/59, "Radiobiology at Hanford," Richland Chapter of FFA, Richland, Washington.

R. F. Foster, 5/12/59, "Aquatic biological problems associated with radioactive waste disposal," Washington State College, Pullman, Wash. (exchange seminar)

c. Biology Seminars

R. T. O'Brien, "Radiation effects on ion transport in yeast", 5/13/59.

M. F. Sullivan, "Nucleic acid metabolism and radiosensitivity," 5/20/59.

E. Publications

a. HW Publications (internal distribution)

None

b. HW Publications (external distribution)

Kornberg, H.A., "On the Passage of Pairs and Elements Through Food Chains," Document HW-60127 (UNCLASSIFIED) May 1, 1959 (in press).

c. Open Literature

None

OPERATIONS RESEARCH AND SYNTHESIS OPERATION MONTHLY REPORT

May, 1959

ORGANIZATION AND PERSONNEL

Clee L. Childress was transferred from Electronic Data Processing Operation of the Contract and Accounting Operation as a Mathematician, effective June 1, 1959.

OPERATIONS RESEARCH ACTIVITIES

Input-Output Simulation Model

The general computing program for models of this type is virtually complete. Since this system is a generalization of the classical least squares regression problem, it will be useful in connection with many standard statistical curve fitting problems in addition to the specialized use for which it was formulated.

The present stage of development work required to utilize the generalized classical linear methods of estimation in connection with the investigation of causal interrelationships has been completed and emphasis will now be placed on the utilization of these techniques to formulate plant models. A report summarizing the work to date has been written and will be used as a basis for the presentation to Operations Research personnel from other GE components.

OPERATIONS ANALYSIS STUDIES

Redox Dissolver Study

The basic techniques developed in connection with the input-output simulation model are being used to study an operational problem in the Redox plant. Although the basic data to which these methods are being applied have been obtained, there are still difficulties in this connection which must be resolved before testing can begin. In the meantime, a large number of potential models have been formulated through discussion with the CPD personnel involved.

Z Plant Information Study

On Wednesday, May 6, 1959, a complete progress report was presented by the study team to interested managers. At this time the team was informed that progress to this point was acceptable, and that the effort would continue with full support along the course proposed. On May 26 the program for the APR was reviewed with the IBM customer-engineer and the

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official release for equipment assembly was given by authorization from A. E. Smith of the Research and Development Operation, CPD.

Present effort is being directed toward defining the information output required of the test system so that 709 programming can be accomplished, the design of production equipment modifications necessary for mechanical data recording, and the design of a communications system between the process line and the central recording station.

FPD Process Control and Experimentation

Data resulting from further runs conducted at the pilot plant in connection with locating the optimum preheat-submerge cycle were analyzed. These represented partial data from a 3^3 experiment in which silicon content in the canning bath was the third variable. A report was issued discussing the results of this partial analysis. The remaining data are now available for analysis.

Quality Certification Program

An accelerated sampling and measuring program was undertaken during the middle of May in order to more quickly provide data necessary in connection with setting up the quality certification program. The data obtained consisted of total external bond counts, residual can wall and tube wall thicknesses, and destructive test results associated with the integrity of the bonding layer. Repeat bond count measurements were taken in order to determine the reproducibility of the bond counter. Firm proposals as to the required sample sizes and methods of data recording should be obtained from the analysis of these data.

Fuel Element Failures

A report was issued summarizing the results of the analysis of rupture index data. Of principal interest was the relationship between the rupture index and the corrosion index of a given tube. The large variability associated with the rupture index obscured any relationship that one might expect to find based on theoretical considerations.

An analysis was made of hot spot and warp data from several production tests. It had been decided previously to restrict the study to the central portion of the tubes where rib marks were more readily discernible, since the location of the warp and hot spots was of interest. The results make it possible to predict what effect reducing the warp by a given amount should have on the frequency of hot spots, and hence, presumably, on the hot spot failure rate.

Reactor Calculations

In view of the interest being shown in connection with this study concerned with the accuracy of reactor power level determination and

[redacted]

recording, a preliminary report will be issued soon covering several aspects of the work such as possible sources of error, their potential effects on the calculation of power levels, and how one might obtain estimates of these errors.

Process Tube Leaks

Probolog data from F reactor since January, 1958, indicative of the amount of external corrosion experienced by a given tube were analyzed. The purpose of this analysis was to determine how one can best characterize tubes likely to show severe external corrosion, and hence become good candidates for a tube leak. Many variables are involved, but it appears that time in the reactor plus general location of the process tube may permit more efficient scheduling of the probologging operation. A report was issued summarizing results thus far obtained, and indicating areas of future study.

CPD Control

The study undertaken to locate sources of variation affecting material control in the PRO dissolvers was continued. This problem is important from a criticality as well as from an accountability viewpoint. Significant trends in percent recovery of different batches, undesirably large between batch variation, and appreciable heel buildups have been detected.

Radiation Protection Studies

A report describing the type of experimentation and results to be expected during the course of the study was issued. A second report describing the results of an experiment conducted to evaluate the isotropic nature of the radium gamma calibration source will be issued early in June. An experiment designed to evaluate the effects of exposure time and distance on the inverse square law was partially completed during the report period. The film has been developed and is now waiting to be read on the densitometer.

Discussions were held with Exposure Evaluation and Records Operation concerning the allocation of the gamma calibration film set to the range 0 - 1000 mr. so as to maximize the precision of estimating integrated dose in the < 3 r per year range.

Systems Reliability

The Research and Engineering Operation of IPD has requested that work on a systems reliability study of the K reactors initiated by CE & U be continued and extended as an operations analysis program. In connection with previous work, the reliability formula which was finally derived was found to be extremely cumbersome. For purposes of a preliminary crude estimate of 25-year reliability, the formula was drastically simplified so that it could reasonably be treated with a desk calculator.

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Since the number obtained was not unrealistic, it was decided that the complete formula should be programmed for digital computation.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program - Metallurgy

Consultation continued with Fuels Design Operation concerning the statistical analysis of a recent notch bend experiment to investigate fracture moment and fracture angle of zircaloy-2 as a function of notch orientation, temperature, percent cold work, and hydrogen content. Questions about the theoretical implications underlying the use of the analysis of co-variance to correct to a uniform notch depth were answered, and a method of analyzing corrected data by means of a non-orthogonal analysis of variance was devised.

Personnel of Physical Metallurgy Operation have noted that electron micrographs of irradiated thin uranium plates possess tracks of varying lengths, the number of tracks per photograph increasing with irradiation time. One possible explanation is that the tracks were left by high energy fission fragments; and the observed track length is the projection normal to the plane of the micrograph of the distance that the fission fragment traveled in the uranium plate following the fission process. To test this hypothesis the distribution function of the projected fission fragment track length was derived. Empirical distributions are being compared with the theoretical model.

4000 Program - Swelling Studies

Study continued on the mathematical model for the distribution of inert gas bubble centers with respect to the interface of a cross-sectioned irradiated uranium cylinder. More experimental data are being obtained in an effort to discover the relationship between apparent bubble distortion and the annealing and etching processes in sample preparation. Comparison of void fraction estimates calculated from observed bubble distributions in the pre- and post-annealed states agree to within experimental error with measured densities which indicates that distortion, while existent, is not sufficient to affect seriously the interpretation of the micrographs.

4000 Program - Plutonium Recycle

Ceramic Fuels Development Operation is in the process of calibrating their gamma ray densitometer for the density measurement of PRTR fuel rods. Calibration curves and accompanying precision statements were constructed for the estimation of UO_2 density as a function of gamma ray densitometer scale reading and fuel rod diameter.

Statistical analysis was initiated of data from the recent PRTR containment vessel test in order to determine the precision of leakage rate estimates.

 [redacted]

6000 Program - Biology Research

A joint meeting was held with Radioecology Operation and Data Processing Operation to consider the feasibility of programming an iteration scheme for the least squares estimation of the parameters occurring in a linear combination of exponentials. It is proposed to fit this type of model to data from an experiment in which radioactive cesium was administered to an aquatic community.

Work continued on the statistical treatment of mortality data from miscellaneous fish tests. Best critical regions which are similar, in the Neyman sense, to the sample space have been derived for tests of a certain class of statistical hypotheses regarding fish mortality.

6000 Program - Atmospheric Diffusion Studies

Work continued on the derivation of statistical techniques for data analysis of the pending Air Force-AEC diffusion and deposition study to be conducted on the Hanford reservation. Non-parametric techniques for estimating crossed-wind distributional parameters, vertical distributional parameters, and total flux parameters have been developed up to certain calibration information which it is hoped will be available later this month from initial diffusion experiments. Current effort is directed toward understanding the physics of the alpha energized zinc-sulphide particle counter which will be used to measure the particle concentration on filter samples, so that the precision of individual sample flux estimates can be ascertained.

6000 Program - Biophysics Research

In connection with the calibration of the whole body monitor, the problem was considered of optimizing sensitivity for a particular isotope as a function of the portion of the energy peak scanned. The solution was provided in terms of the position of the peak of the energy spectrum and the instrument resolution for a specific isotope.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Fuels Preparation Department

Minor injury control charts were prepared for FPD based on data from the past two years. Injuries were categorized into four groups, where, within each group, the general cause of accidents was considered to be common.

Chemical Processing Department

A close watch is being maintained on final product purity data to insure that specifications based on quarterly tolerance statements will be met.

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Several nomographs were prepared as aids in the routine application of mathematical formulae which are used in inventory control.

The analysis performed to determine whether the neutron emission rate of a given material is related to the weight or volume of the batch in question was completed, and a report was written.

Construction Eng. and Utilities Operation

A method for evaluating the variability associated with fair cost estimates was devised for the Estimating Operation. The method is presently being applied to each fair cost estimate to gain operating experience in its use.

Contract and Accounting Operation

A paper, "Some Statistical Aspects of B-PID's and Ending Inventories," was presented at the 1959 AEC-Contractor's SS Materials Management Meeting in Germantown, Maryland, May 25-28, 1959, by K. B. Stewart.

Assistance was given SS Measurements personnel in reconciling differences found to exist between IBM listings and ledger records with respect to the reactor inventory of U^{235}.

Relations Operation

A GE News readership survey is to be conducted in the near future. Assistance was provided in the selection of a sample, where primary attention was given the problem of selecting the sample such that comparisons between different employee groups could be made.

Consulting services were provided to personnel of Relations Operation in connection with a contemplated plant-wide depth-interview attitude survey.

Carl A. Bennett

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

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VISITS TO HANFORD WORKS

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

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
K. B. Stewart	5-25 to 5-28	AEC-Nuclear Materials Washington, D. C.	Present paper	H. R. Freitag	Yes
L. G. Waters	5-8-59	GE meeting San Francisco, Calif.	Attend Mfg. Serv. Integrated Systems Project Meeting	H. F. Dickie	No

PROGRAMMING OPERATION
MAY 1959

A. FISSIONABLE MATERIALS - 2000 PROGRAM

A review of radioactive isotopes which may be best suited for power production to replace batteries for the operation of remote and unmanned instrumentation has shown uranium-232 and its daughter thorium-228 to have significant potential. Although U-232 has a long half-life (74 years) its potential equilibrium energy production on a weight basis amounts to one KW of heat from 210 grams of the isotope. This level of energy release is caused by the "growing-in" of the thorium-228 daughter which has a half-life of 1.9 years with potential energy production of one KW of heat from 6.4 grams. Among those isotopes that can be obtained pure without isotope separation processes and with half-lives measured in years, thorium-228 has by far the greatest potential as a power source. In addition it can probably be produced in pure form by known chemical means. The weight of some of the pure isotopes which may yield one kilowatt of heat are compared as follows:

Table I
Isotopes Potentially Useful as Power Sources

Isotope	Half-Life, Years	Grams/Kilowatt
Th-228	1.9	6.4
Po-210	0.38	7.0
Cm-242	0.45	8.0
Ce-144	0.78	36
U-232	74	210
Sr-90	28	930
Pm-147	2.5	1760
Pu-238	90	1830

The main disadvantage of U-232 is the time required to reach the equilibrium heat generating value. In three years about 80 per cent of this value is attained. However, pure Th-228 could be "milked" from a "stock pile" of U-232. For each kilogram of U-232 aged for one year slightly more than seven grams of Th-228 could be routinely obtained. The only practical source of U-232 would be from the irradiation of Th-230 which is associated with all uranium ores, generally at about sixteen grams per ton of uranium. In U.S. ore mills alone hundreds of kilograms of Th-230 are delivered to waste each year. Facilities would have to be provided at uranium ore processing plants to recover it from these waste streams. There appear to be feasible techniques for the production and recovery of pure U-232 from irradiated mixtures of Th-230 and Th-232. This is of interest because most uranium ores contain Th-232 as well as Th-230. Investigation is continuing on the feasibility of obtaining kilogram quantities of Th-230 as a by-product of uranium ore processing.

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B. REACTOR DEVELOPMENT - 400C PROGRAM

1. Plutonium Recycle Program

RBU Computer Code

The Monte Carlo and associated portions of the code are now in usable condition. One sample problem has been run, which was chosen for its direct applicability to the Plutonium Recycle Program. This was a calculation of neutron flux distribution in 48 energy groups and 5 radial zones in a 1/4" plutonium metal rod immersed in D_2O. This and similar calculations will be applied to predictions of temperatures and heat generation rates of self-shielded plutonium fuel elements. Certain minor changes in the code to improve its utility and accuracy were suggested by the calculation, and these are now being incorporated.

The diffusion and burnup portions of the code are also essentially complete, although a realistic sample problem has not as yet been tried. The input code is progressing satisfactorily. A status report on the entire project is now being prepared.

Meleager Fuel Cycle Analysis Code

The Meleager codes have been rewritten to allow greater flexibility. High speed computation is now available for survey work where large scope rather than extreme accuracy is important. More detailed calculations may also be performed; these may include up to 150 isotopes. Provision has been made to calculate physics parameters at a predetermined value of the average multiplication constant, as well as in the conventional flux-time steps.

Higher Isotope Studies

Determination of the higher Americium and Curium isotope content of recycled plutonium fuel continued. Although such elements may be of interest during processing, the amounts are very small and probably not considered of interest from the standpoint of separate recovery from the fuel of a single reactor.

C. BIOLOGY AND MEDICINE - 6000 PROGRAM

Radiological Consultation

A paper entitled "Biological Implications of Radioactive Wastes" was reviewed. Comments on present radiological limits and recently approved changes in these limits were forwarded to the General Manager, HAPO. A review of the problems with reactor effluent water along with recommendations concerning the course of action to be followed was prepared and transmitted to IPD.

1240447

A meeting of the General Electric Reactor Safeguards Committee was attended in New York City on May 7 and 8, 1959. The report of the Small Boiling Water Reactors Subcouncil was submitted at this meeting.

Revisions continued on the NCRP Handbook on Safe Handling of Radioisotopes. At the end of the month this revision was 90 per cent completed.

Bio-Medical Program Directors Meeting

Arrangements for the meeting on June 8 and 9 of the Program Directors for the Division of Biology and Medicine were continued. The two day schedule will include papers on HLO programs, a tour of HAPO facilities, and opportunity for small group discussions of R & D work. A program document consisting of abstracts of the various speeches from the program was prepared for distribution.

D. OTHER ACTIVITIES

Hanford Laboratories resources for performing research and development were described in detail in a document prepared as background material for forthcoming Congressional hearings on AEC laboratories.

HLO's office and other work space needs through June 30, 1959, were surveyed and ways of meeting these needs were recommended.

Arrangements were made for a visit on May 21 and 22 by 13 representatives of the Euratom program. The Plutonium Recycle Program was reviewed for the visitors who in turn reviewed their program plans for HAPO comment.

Arrangements for the next Hanford Science Colloquium, on July 7, were completed. Prof. Herman Wold, of the University of Uppsala, Sweden, will discuss his work in the field of statistics.

Milton Lewis
for Manager, Programming

M Lewis:dl

1240448

VISITS TO HANFORD:

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	HAPO Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
James R. Burr E. J. Leshan M. A. Temme	5/4/59 - 5/29/59	Advanced Technology Laboratories, Mountain View, Calif.	Work on the RBU computer code.	J.R. Triplett	No	700, 713
H. Susskind	5/14/59	Brookhaven National Lab., Long Island, New York	Discuss thorium limits.	J.W. Healy	No	300, 328
C.C. Gamertsfelder	5/14-15	GE - ANP Cincinnati, Ohio	Reactor accident calculations.	J.W. Healy	No	300, 328-325 100-F, 108-F 622
William Lowe	5/18-19	Edison-Electric Inst. (Warren, Pickard & Lowe, Washington, D.C.)	Discussed waste disposal.	J.W. Healy	No	300, 328

VISITS TO OTHER INSTALLATIONS:

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
S. Goldsmith	5/6/59	Employment Security Agency Grangeville, Idaho	Speaker for Grangeville High School Career Day.	R. Fuhriman	No
J. W. Healy	5/7-8	General Electric Company New York City	Attend meeting of General Electric Reactor Safeguards Council.	K. Cohen	No

RADIATION PROTECTION OPERATION
MONTHLY REPORT - MAY 1959

A. ORGANIZATION AND PERSONNEL

L. B. Priest transferred into the Exposure Evaluation and Records Operation on May 11, 1959. Harriet M. Baird transferred from Calibrations Operation on May 25, 1959 to the Analytical Laboratories, CR & D. Genevieve D. Vaught transferred from Exposure Evaluation and Records to Calibrations. The force of the Radiation Protection Operation remained at a total of 132.

B. ACTIVITIES

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

One minor case of Ru^{106} deposition occurred as a result of inadvertently placing highly contaminated equipment into a beaker of HCl at the 327 Building. The whole-body counter indicated a deposition of $\sim$ 0.07 μc Ru^{106} ($\sim$ 2% of MPL).

Three cases of localized exposures in excess of current permissible limits occurred. These involved: protective apparel contamination at the 105-DR reactor rear face with a resultant estimated skin dose of 4 rads including 1 r, a dose to the skin of the heel of a process operator in the 100-H reactor as a result of a contaminated particle lodged in employee's shoe, a maintenance employee at the 105-K Area receiving an estimated dose to the gonads of 250 mr as a result of sitting on a contaminated pipe.

Approximately one million pounds of salvage and scrap material were surveyed and released from the Hanford 101 storage area.

Additional testing of the reduced area plutonium technique was accomplished in the bioassay laboratory. Higher than acceptable backgrounds still remain on the test samples, apparently due to transfer of residue from the electrodeposition plate to the NTA emulsion slide.

About 26 people were examined in the Shielded Personnel Monitoring Station. Eight of the 26 were associated with minor plant incidents in which internal deposition was possible. Six of the eight employees showed no measurable deposition. Positive traces of Sc^{46}, Zn^{65}, or Ru^{106} were found in the other two employees. Background measurements of Cs^{137}, K^{40}, and Zn^{65} were made for the 18 routine studies.

A team was dispatched to investigate a leaking container after notification of the situation from the Railway Express Office at Portland, Oregon. The leakage was from a container of UNH shipped from HAPO. Minor floor contamination was removed. The defective container was returned to HAPO.

Unexplained contamination in 234-5 waste water discharged to the new ditch increased sharply to 10^{-4} μc Pu/cc. Although subsequent samples decreased to 10^{-6} μc/cc, investigation is containuing to determine the source of this contaminant.

1240450

The search for improved methods for I^{131} detection and measurement in milk and produce samples continues. The produce sampling program was curtailed so that increased effort could be diverted to study of precision and accuracy of the Sr^{90} analytical method.

The usual seasonal decrease in isotopic concentrations and GI tract exposure estimates were observed with the increased flow of the Columbia River. The average river flow for May, 1959, was 208,000 cfs, against 108,000 cfs for April, 1959.

C. EMPLOYEE RELATIONS

There were two medical treatment injuries for a frequence of 0.98. No security violations occurred during the month.

No suggestions were received for evaluation. One suggestion in pending in RPO for evaluation. No awards were made.

A substantial amount of testimony was prepared and presented at the Wonacott arbitration case held early in May.

An orientation and training session was conducted for the Construction Building Trades Business Agents. The interest and appreciation were noteworthy.

A lecture and demonstration on radiation detection was presented to about 200 grade school students and faculty at the Mark Twain School in Pasco. This activity was scheduled through the HAPO Speakers Bureau.

Radiation protection displays were presented on Armed Forces Day at the Larson Air Force Base and at the Umatilla Ordnance Depot. An estimated 2,000 persons visited the displays.

D. SIGNIFICANT REPORTS

HW-56827 Rev. - "A Personnel Film Badge Neutron Dosimeter" by Frank Swanberg, Jr.

HW-60413 - "Analysis of Radiological Data for the Month of April 1959" by R. L. Junkins.

HW-60530 - "Waste Disposal Monitoring Activities Summary - May 1959" by K. F. Baldridge.

HW-60548 - "Monthly Report - May 1959, Radiation Monitoring Operation" by A. J. Stevens.

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

Report of Invention - "A Field Air Sampler for Radiological Defense Use, for Monitoring the Spread of Air-borne Contaminants from Atomic Weapons" by Leo F. Kocher and Frank Swanberg, Jr.

1240451

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings
G. Lippert	5-15-59	Victoreen Instrument Co., Cleveland, Ohio	To view and discuss film badge processing machine and pencil reader.	LF Kocher FL Rising	No	3706:300
R. Anderson	5-15-59	Arva Electronics, Seattle, Washington	Same as above.	Same as above.	No	3706:300
J. C. Veburg R. Schmitt	5-19-59	Tracerlab, Richmond, California	Same as above.	Same as above.	No	3706:300
L. G. Haskell	5-19-59	Salt Lake Pipe Line Co., Salt Lake City, Utah	Discuss radiation safety aspects relating to work with Actinium-124.	B. G. Lindberg	No	703:700
Art Garton A. T. Neale	5-28-59	Washington Pollution Control Commission, Olympia, Washington	Discuss evaluation of radioactivity in Columbia River.	HV Clukey RL Junkins	No	3746, 329 300

VISITS TO OTHER INSTALLATIONS

H. V. Clukey K. R. Heid	5/4-8/59	Reynolds Electrical & Engineering Co., Mercury, Nevada	AEC Emergency Radiological Assistance Team training.	W. S. Johnson	Yes
H. V. Clukey	5/21 - 5/23/59	APED (GE) San Jose, California	Seek housing facilities for transfer.	G. Sege M. W. Hall	No
A. R. Keene	5/19 - 6/1/59	OEEC Symposium on Health Physics, Riso, Denmark	Present a paper.	Dr. K. Z. Morgan	No
A. J. Stevens	5/11 - 14/59	University of Kansas Lawrence, Kansas	Meet with AEC Fellows attending the U of K.	Dr. E. I Shaw and students	No

VISITS TO OTHER INSTALLATIONS (con't.)

H. J. Paas L. C. Rouse	5/16/59	Larson Air Force Base, Moses Lake, Washington	Display for Armed Forces Day.	-	No
V. M. Milligan	5/26/59	Railway Express Office, Portland, Oregon	Conduct a radiation survey.	-	No
J. W. Vanderbeek	5/12 - 13/59	G.E. Schenectady, New York KAPL Schenectady, New York	Represent HAPO at a safety and plant protection conference and discuss radiation protection practices at KAPL.	J. V. Grimaldi L. J. Cherubin	No
M. W. McConiga R. C. Dozer	5/16/59	Umatilla, Oregon	Display for Armed Forces Day.	Col. Longdon	No

1240453

ENVIRONMENTAL MONITORING - RESULTS (April 26, 1959 - May 24, 1959)

Sample Type and Location	Activity Type***	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	0.6	% MPC_{GI}	--
Separations Areas	Gross Beta	1.0×10^{-6}	µc/cc	--
Pasco	Isotopic	0.3	% MPC_{GI}	--
Kennewick	Isotopic	0.1	% MPC_{GI}	-2
Richland	Gross Beta	3.8×10^{-8}	µc/cc	--
Columbia River Water				
Above 100-B Area	Gross Beta	6.0×10^{-9}	µc/cc	+2
100-F Area	Isotopic	3.8	% MPC_{GI}	-2
Hanford Ferry	Gross Beta	3.6×10^{-5}	µc/cc	-2
Pasco	Isotopic	0.8	% MPC_{GI}	--
McNary Dam	Gross Beta	1.8×10^{-6}	µc/cc	--
Vancouver, Washington	Gross Beta	6.0×10^{-7}	µc/cc	--
Waste Water				
Outlying Test Wells	Gross Beta	3.0×10^{-6}(Max)	µc/cc	--
Reactor Effluent Retention Basins to River	Gross Beta	26,000	curies/day	--
Atmosphere				
Gross Dose Rate -				
Project	Gamma	0.8	mrad/day	--
Environs	Gamma	0.5	mrad/day	--
I-131 Separations Areas	I-131	2.5×10^{-13}	µc/cc	--
I-131 Separations Stacks	I-131	8.7	curies/week	--
Active Particles - Project	--	17	ptle/100 m^3	--
Active Particles - Environs	--	26	ptle/100 m^3	--
Vegetation				
Separations	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Residential	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Eastern Washington and Oregon	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Fission Products less I-131 - Wash. and Ore.	Beta	6.2×10^{-5}	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.

*** Total Beta, as reported in previous reports, was changed to Gross Beta to conform with the Waste Disposal Hearings Glossary.

1240454

EXPOSURE EVALUATION AND RECORDS

Exposure Incidents Above Permissible Limits

	Whole Body	Localized
May	2	1
1959 to Date	6	6

Gamma Pencils

	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
May	21,540	243	8	2
1959 to Date	150,112	440	16	6

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)	Average Dose Per Film Packet mr(s)
May	9,402	970	93	15	44	7.66	19.10
1959 to Date	52,040	4,368	451	70	248	5.24	18.37

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
May	1,427	1	1	0	10
1959 to Date	6,253	19	2	0	27
Fast Neutron					
May	87	1	9	0	10
1959 to Date	391	3	13	0	26

Bioassay

		May	1959 to Date
Plutonium:	Samples Assayed	875	3,968
	Results above 2.2×10^{-8} μc/sample	61	180
Fission Products:	Samples Assayed	845	3,813
	Results above 3.1×10^{-5} μc FP/sample	4	17
Uranium:	Samples Assayed	243	1,401
Confirmed Plutonium Deposition Cases		0	5*

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

Uranium Analyses

Sample Description	Following Exposure Units of 10^{-9} µc U/cc Maximum	Average	Number Samples	Following Period of No Exposure Units of 10^{-9} µc U/cc Maximum	Average	Number Samples
Fuels Preparation	22	3.3	46	11	2.3	41
Hanford Laboratories	9.8	3.3	16	7.9	2.2	22
Chemical Processing	30	4.7	43	32	5.8	59
Chemical Processing*	63	21	5	16	7.6	5
Special Incidents	0	0	0	0	0	0
Random	0	0	0	0	0.7	4

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

Thyroid Checks	May	1959 to Date
Checks Taken	0	0
Checks above Detection Limit	0	0

Hand Checks		
Checks Taken - Alpha	28,582	177,391
- Beta-gamma	17,873	117,566

Skin Contamination		
Plutonium	19	89
Fission Products	76	222
Uranium	8	57

CALIBRATIONS

Portable Instruments	Number of Units Calibrated May	1959 to Date
CP Meter	938	4,788
Juno	278	1,472
GM	1,331	6,777
Other	198	1,016
Total	2,745	14,053

Personnel Meters		
Badge Film	916	4,615
Pencils	-	5,248
Other	382	2,160
Total	1,298	12,023

Miscellaneous Special Services	459	1,613
Total Number of Calibrations	4,502	27,689

AR Keene

Manager
Radiation Protection

124045b

AR Keene:kc

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - MAY 1959

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 2.22, which is considered below average experience.

There were no security violations charged to the Operation.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 17,102 hours. This includes 13,358 hours performed in the Technical Shops, 852 hours assigned to Minor Construction, 122 hours to other project shops, and 2,770 hours to off-site vendors. The total shop work backlog is 22,112 hours of which 50% is required in the current month, with the remainder distributed over a three month period. Overtime worked during the month was 6.5% (1040 hours) of the total available hours.

Distribution of time was as follows:

	Man-Hours	% of Total
Fuels Preparation Department	2738	16.0
Irradiation Processing Department	738	4.3
Chemical Processing Department	880	5.2
Hanford Laboratories Operation	12381	72.4
Construction Engineering & Utilities	104	.6
Miscellaneous	261	1.5

The number of requests from customers for emergency service remained at a high level necessitating an overtime ratio of 6.5%. Other project shops were utilized to capacity in providing assistance to the Technical Shops.

Two machinists were added to the Technical Shops roll during the month with two more scheduled to report on June 15. Promotional opportunities were provided and accepted by one journeyman welder who was promoted to Specialist - Welding Practices, CE&U, and one secretary who was promoted to a higher grade position in a technical component of Hanford Laboratories.

New equipment received included a vertical boring mill, a 14" heavy-duty lathe, and a No. 3 vertical milling machine.

Security performance was considered satisfactory with no violations. Safety performance was considered satisfactory with 4 medical treatment injuries and no major injuries. Absenteeism was considered higher than normal for this period caused mainly by a form of influenza.

RADIOGRAPHIC TESTING OPERATION

The activity for the Radiographic Testing Operation was below normal this month because of two situations. Foremost in reducing output was the move of the field facilities from 200-E Area to White Bluffs. Also, the monthly cut-off date for the operation was moved up to the 20th of each month to advance the reporting date for the monthly report. Accordingly, the following figures are based on a three week period. A total of 2,926 tests were made, of which 640 were radiographic (including x-ray and gamma-ray) and 2,286 were supplementary tests. Out of a total of 2,382 man-hours, 889 (64.3%) were used in connection with radiographic tests, and 493 (35.7%) were used on supplementary tests. The supplementary test work included: dimensional measurements (micrometric and plug gage), eddy current, penetrant, ultrasonic (flaw detection and thickness measurements) and stress measurement (stress coat and strain gages).

The number of pieces handled this month was about normal totaling some 1,795 items. On the same basis, the feet of material represented by the foregoing was about normal amounting to 11,498 feet. Work was done for 17 different organizational components representing most of the operating departments and service organizations. A total of 21 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 9 different occasions for advice and information relating to general testing theory for other than the jobs tabulated in Part II - Testing Statistics.

The single largest activity this month has been the move of the field facilities, and establishment of the tube testing and treating facilities at White Bluffs.

The field facility equipment and personnel move was completed on 5-25-59. Some minor restoration work remains to be done on the Chemical Processing Department facilities in 200-E Area.

About one week delay over the established tube treatment schedule has been encountered in the tube facility. Construction schedules have not been able to be maintained on the pickling tanks and the autoclave. Installation of the acid tank plastic liner is 80% complete. Acid recirculation piping and pump installation is also about 80% complete. It is expected that both of these items will be completed 6-3-59.

The only major item remaining on the autoclave is the insulation which is expected to be completed also at 6-3-59. The water injection pump and control instrumentation installation are essentially complete.

If work continues at the above rate it is anticipated that preliminary pickling can be done on 6-5-59.

Testing Statistics

Component	No.of Tests	Ft.of Weld or Material	No.of Pieces	Description
CPD	68	70.0	45	Purex concentrator redox dissolver, H.S. column T-H3 Purex facility.
CEO	0	0.0	0	Final report on PRTR containment vessel welds.
FPD	9	1.5	2	1/4" wall x 2" O.D. x 30" long UO_2 fuel rod.
HLO	2742	10990.0	1723	316" SS electrical conduit couplers 9/16" O.D. x 8' long zr-clad UO_2 fuel rods; Al-SS piping; .505" x .035" wall x 10' long zr-2 tubing; .680" x .030" wall x 7' long zr-2 tubing; PRTR zr-2 process tubes; Trans-Pu and Palm fab programs; 16" O.D. x 1/2" SS pipe; Ti plates and tube bundle; 1.8% and 5% Pu-Al fuel elements; Thermocouples; B-F3 tubes; 33" long x 9/16" O.D. 1.8% Pu-Al fuel rod.
IPD	107	437.0	25	In-pile tube AEC 160 loop project; 190 B annex piping; intake and discharge headers 190-KE.
TOTALS	2926	11498.5	1795	

FACILITIES ENGINEERING OPERATION

Projects

There were 21 authorized projects at month's end with total authorized funds of $8,423,000. Total estimated cost of these projects is $8,606,500.

Project proposals and project planning for Radiometallurgy Building 327 were completed during the month with the transmittal of four project proposals to the General Manager.

Six new projects are in the proposal preparation stage.

The attached projects report details the status of individual projects.

Engineering Service

Title	Status
Removable Target Pit Grating 3745-B Building	Installation scheduled for completion 6/3/59.
Clean Air Ducts - 326 Building	R. A. Pringle and Son was low bid. Work to start during June.
Renovate Room 30-C - 326 Building	New equipment was received for installation.
Improve Lighting - Rooms 11-1A & B 325 Building	Fixtures on hand for installation.
Design & Install Fire Alarm System 314 Building	Design work completed. Construction Operation is preparing installation estimate.
Air Balance - 108-F Building	Field work is in progress.
Gamma Irradiation Facility - 3730 Building	Tank and caisson in place. Roof hatch and hoist supports are being installed. Radiation warning system is nearly complete.
Kitchenette Facility in 326 Bldg.	Work in progress.
Erection of Towers for Atmospheric Physics	Work complete.
Study - Layout of Biology Facilities	Study complete.
Isolate crane conductors - 314 Building	Work in progress to isolate crane conductors. This will decrease hazardous condition in building.
Dog Isolation Facility - 141-FS Building	Work 90% complete.
326 Building Retention Waste Sump Modifications	Engineering work in progress.
Temperature Control for Fish Troughs - Biology Operation	The requisitions for the required equipment are out for bids.
Air Balance & Control 328 Building	Preliminary volume checks are being made prior to adjustments. A temporary second floor temperature control point is in service and has resulted in more constant temperatures.

Title	Status
Graphite Storage Building	The work to be performed consists of a footing and starter wall; a four inch floor slab and moving and installing a 40' x 80' Army building on the block wall.
HLO Plan	A study has been initiated to develop a plant layout of HLO structures, utilities and grounds including future plant additions.

Drafting & Design Service

Design and drafting work in progress includes the following:

In-Reactor Creep Measurement capsule.
Mechanism for removal and containment of ruptured irradiated fuel - 3x3 loop ETR.
Equipment for examining discharged fuel elements - ETR.
Modifications to 14 ton shipping cask.
Equipment for High Level Radiochemistry Facility - 325-A Building
a. Manipulator dolly
b. Mock-up wall
c. Miscellaneous items, tongs, brush, plugs
d. Three ton liquid sample cask
Monorail feed mechanism for swage - 325 Building basement.
PRTR prototype loop - As-Built - 314 Building.
Mechanism for moving samples through Gamma recording instrumentation.
Cobalt-60 source holder and tong mechanism.
Hand feed for swage - 325 Building basement.
Fuel element X-Ray photometer.
Test set up design - fuel, fuel and foil holders, and graphite - 305-B Building.
Transistorized circuits for counters.
Traverse counter drive - 305 Building.
Uranium burning facility.
Modify existing PRTR shim control drawings.

Also, work is being performed for layout and details on projects CGH-834, Modifications and Additions to High Pressure Loop - 189-D Building, AEC-167, Job 0084, Pickling & Autoclaving Facility for Zirconium Material, and CGH-838, Fission Product Volatilization Studies Test Facility - 292-T Building.

Maintenance and Building Engineering - Landlord Functions

Costs	- April	-	$108,446
	March	-	$116,249

Fiscal year to date expenditures are $1,017,248, which is 82% of budget. Expenditure forecast was $1,045,300 or 84%.

1240461

Analysis for Month of April: Costs were within $300 of those predicted for this month. The year-to-date costs were 1.3% below the liquidation. It is anticipated that the $17,538 over-liquidation will be reduced in May by about $2,000.

A fixed price work order has been issued for the rest room and office addition to 3702 Building.

A work order has been issued for construction of a parking lot and retaining wall west of 328 Building.

Partition changes were made in the north end of 3702 Building to accommodate the recruiting staff. The Employee Relations offices were reassigned, in keeping with the recent organization.

A fixed price work order was issued for the contingency maintenance of the 325 Building supply and exhaust fans.

Miscellaneous

Approximately 150 drawings including sketches, work sheets, and formal drawings were completed by the Drafting Component during the month.

Approximately 14,000 square feet of prints were reproduced during the month.

The total estimated value of the 22 requisitions issued during the month was $52,000. Material procurement and control is being performed for a greater number of HLO projects.

The next Third Party Inspection of HLO pressure vessels is scheduled for June.

TECHNICAL INFORMATION OPERATION

Arrangements are being concluded to transfer to Technical Information the responsibility for handling the clearance of technical papers and speeches for HAPO. Technical Information will also be responsible for the clearance of non-technical articles originating within HAPO. The present date for the transfer is June 30. J. E. Brown, Relations Operations, will transfer to Technical Information Operation at the time that the function is reassigned.

The Technical Information budget for FY-1960, approved some time ago, has been subdivided into Unit budgets. Some individual items, notably the allotments for book and periodical purchases, and for Data Processing charges, are cause for concern but may work out satisfactorily. The budget totals appear to be in line with present operating experience.

A memordum was sent to all Department Managers concerning compliance with HAPO OPG 1.5 on the release of official correspondence and documents. The memorandum pointed out the precautions to be observed before sending un classified reports offsite. The response from the Departments has been excellent and modifications of existing OPG's are planned.

1240462

The Commission has asked Technical Information to send directly to Kaiser Engineers such technical reports as they will need in connection with the construction of the NPR. Kaiser Engineers have been designated an authorized AEC Accountability Station so that permanent transfers of accountability can be made. All reports going to them from Technical Information will be approved by the Manager, Process Design Operation, NPR Project Section.

Details are being worked out to transfer to the City of Richland a number of books presently charged from the Plant Library to personnel in the Police Operation, the Fire Operation, and the Public Works and Recreation Operation of Community Operation. Present plans are to transfer these books to the Richland Public Library who will then re-charge them to the city employees involved. Books charged to personnel in General Electric's Public Health group will be transferred to the Benton Franklin Public Health District.

The three fuel element projects which were submitted for classification review last month have been declassified. They are:

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

The questions raised last month by TISE and HOO regarding the proper categorization of the Fuels Development Operation Quarterly Report (HW-58205) have been resolved. All copies of the report are being recalled for minor revisions and will be redistributed in accordance with the original distribution list. Some ground rules to avoid recurrence of this problem will be forthcoming from HOO.

Work Volume Statistics

	April	May
Document Distribution and Files		
Documents routed and discharged (copies)	16,970	14,437
Documents issued (copies)	13,435	10,570
Documents sent offsite (copies)	1,305	6,444
Document reserves filled (copies)	941	931
Documents picked up and delivered	18,684	19,573
Document Accountability		
Holders of classified documents whose files were inventoried	570	324
Documents inventoried in Files (copies)	6,347	25,210
Documents destroyed or retired (copies)	4,003	4,842
Documents revised (copies)	1,636	1,723
Documents pulled and documents filed (copies)	10,902	10,421
Documents reclassified	232	189
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents onsite	204,462	205,508

1240463

Reference and Publication	April	May
Books cataloged (new titles)	96	45
Books added to the collection (volumes)	316	219
Ready reference questions answered by professional staff	142	119
Literature searches by professional staff	116	116
Reports abstracted (titles)	238	249
Formal reports prepared (titles)	15	7
Offsite requests for HAPO reports (copies)	312	235
Reports released to CAP (titles)	76	28
Library Acquisitions and Circulation		
Books ordered (volumes)	500	401
Periodicals ordered	81	117
Books circulated (volumes)	2,046	1,760
Periodicals circulated (issues)	2,911	2,573
Inter-Library loans	119	62
Films borrowed or rented	19	9
Industrial film showings	93	92
Bound periodicals added to the collection	202	194

Library Collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Totals
No. of books	26,357	8,197	1,424	1,943	37,921
No. of bound periodicals	11,984	1	1,431	96	13,512
	38,341	8,198	2,855	2,039	51,433

Classification and Declassification	April	May
Documents, including drawings and photographs reviewed for downgrading or declassification	106	53
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	41	31
Documents submitted to Declassification Branch, Oak Ridge	12	16

Manager
LABORATORY AUXILIARIES

JL Boyd:jcw

1240464

BUDGET CLASSIFICATION Improvements to Production and Supporting Facilities - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60905
MONTH May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CG-731	Critical Mass Laboratory		$1,000,000	100*	0	5-22-58	- - -	2-24-59
		$1,000,000	3-23-59	100*	0	6-15-59	6-30-60	6-1-60
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: D. S. Jackson		

REMARKS: Bids for the construction portion of the project were opened on May 19, 1959. There were eight bids ranging from a low of $442,025, by the Howard S. Wright Construction Company of Seattle, Washington, to a high of $512,960. The three lowest bids were within 3% of each other; the Government Fair Cost Estimate was $408,000. A contract was signed on May 25, 1959 awarding the work to the Howard S. Wright Construction Company. Bids for fabrication of the main control panel were also opened May 19, 1959. Two vendors, Panellit Inc., and Bumstead-Woolford Company met all the requirements of the requisition. Minneapolis-Honeywell differed from the specifications for the mixer and graphic panels, however, because of their favorable bid a request will be made that they rebid in accordance with the General Electric Company Specifications. Other design and procurement of the reactor components is underway.
* Does not include reactor components.

CA-744	Metallurgical Development Facility - 306 Building		$2,685,000	98	3.5	6-30-58	- - -	9-1-59
		$2,623,000	11-5-58	95*	3.5	3-20-59	9-1-60	9-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. T. Lloyd		

REMARKS: * Design of chemical processing, consisting of about 15 drawings, have been added to the design work causing a reduction in the percentage of design completion. The x-ray design drawings will be given to the contractor about June 5, 1959. The material "Vitrabond" ordered by the contractor has not arrived and is causing some delay in construction; this was to have been delivered by May 22nd. Requisitions for all major equipment items have been placed on order. Inspection equipment is being held up pending completion of the cost estimate of the x-ray machine and associated equipment. Relocation of the outside electrical line is complete. The grading on the east of the 306 Building is nearly complete. The exhaust fans Nos. 1, 2 and 3 are being relocated to the existing roof and will be completed on June 1, 1959. The contractor is removing siding from the east end of the building and preparing to place forms for the fire wall.

CA-749	High Level Radiochemistry Facility		$960,000	100	74	6-15-58	- - -	11-21-58
		$960,000	10-31-58	100	75	8-14-58	1-1-60	8-30-59
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: R. W. Dascenzo		

REMARKS: The following construction was performed and material received this month: (1) Approximately 50% of the heavy concrete was pneumatically placed. (2) All of the filter boxes in the ventilation system have been installed except for tie-ins to non-completed equipment. (3) Piping of tanks in the hot liquid storage area is continuing. (4) All large cell doors and operators have been received. (5) Exterior forms for the cell roof structure are being prefabricated. (6) Electrical work for the pumps and instrumentation is continuing. (7) The General Mills strike was settled May 18 and our manipulator will be shipped August 25, 1959. (8) The installation of the 3" SS waste crib line and 6" water line have been completed. (9) All the cell piping has been tested.

BUDGET CLASSIFICATION Improvements to Production and Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW-60900
MONTH May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building	$350,000	$345,000*	100	41	6-23-58	- - -	12-31-58
			4-23-59	100	41	10-9-58	2-1-60	2-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. J. Peterson		

REMARKS: The contractor, Jensen-Rasmussen Company has submitted structural steel drawings, miscellaneous heating and ventilating information, and door drawings exclusive of the crane door. These drawings have been reviewed and returned. The structural steel is scheduled to arrive on the job site the third week in June; the major work should start at that time. The electrical sub-contractor has had some materials delivered to the job site. The CPFF Construction Contractor continued work on the ductwork into the new building addition; this phase of the work is nearing completion. Work progressed on the backfill and compaction for the roadway. Shop work was performed on the wet storage door and the decontamination chamber "V" trough. The revised construction schedule has been forwarded to the Commission.
* The project proposal requested $350,000 and $345,000 was authorized by the Commission.

CGH-819	Increased Laboratory Waste Facilities - 300 Area	$300,000	$30,000	12	0	3-30-59*	- - -	9-1-59
			11-24-58	19	0	11-1-59	- - -	12-30-60
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: J. J. Peterson		

REMARKS:

Architectural, instrumentation, and mechanical design work is in progress. The design schedule has been forwarded to the Commission

* Preliminary engineering was started March 23, 1959 as previously reported.

General Plant Projects - FY 1959

CAH-827	Automatic Columbia River Monitoring Station	$30,000	$27,000	N.S.	0	4-3-59	- - -	6-17-59*
			3-17-59	70*	0	7-15-59	12-31-59	12-31-59
		USING COMPONENT: Radiation Protection				FEO ENGINEER: D. S. Jackson		

REMARKS: AEC - Attempts to incorporate installation of the river pumping system with the construction of the PRTR River and Pump Structures were not successful. The pump system will now have to be redesigned since it will not be practical to install it in these two structures as planned because of backfill and flooding. A revised contract is being negotiated with Carson, Kesterson and Moe, Architects.
GE - Purchase requisitions are in process for monitoring equipment. A work order has been issued for fabrication of the copper clad monitoring tank.
* A-E only.

AM-7300-019 (5-58)

UNCLASSIFIED

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - [illegible]
MONTH: May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CAH-828	Central Storage Facility - 300 Area		$37,400	N.S.	0	3-30-59	- - -	6-5-59
		$37,400	2-18-59	95	0	6-18-59	12-31-59	12-31-59
		USING COMPONENT: Property Accounting				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

Comment issues of the detail design and specifications were issued May 28, 1959.

CGH-829	Building 325 Basement Imporvements		$70,000	100	60	2-13-59	- - -	4-14-59
		$70,000	2-13-59	100	52	3-2-59	9-30-59	9-30-59
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

Work on the truck ramp and access doors started May 6, 1959. The retaining walls are approximately 60% complete. The basement wall has been breached for the roll-up door and the personnel door. Low bidder on the sprinkler system was Grinnel Company; notice to proceed was issued May 25, 1959.

CAH-837	Animal Pens, Isolation and Examination Facilities		$80,000	100	N.S.	3-30-59	- - -	6-3-59
		$80,000	3-17-59	97	0	N.S.	4-1-60	12-1-59
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:

The Architect-Engineers, Carson, Kesterson and Moe submitted detailed design drawings and specifications for comment on May 28, 1959. General Electric Company transmitted construction information for the bid package to the AEC on May 26, 1959.

BUDGET CLASSIFICATION 8910421

General Plant Projects - FY 1959

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW - [illegible]

MONTH May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CGH-840	Sheet Metal Shop Addition - 328 Building	$36,500*	None	None	0	0	0	0	1**	4**	- - -	- - -	4**	12**

USING COMPONENT: Laboratory Auxiliaries

FEO ENGINEER: [illegible] J. Peterson

REMARKS:

The General Electric Company is studying construction of a concrete block structure in lieu of utilizing the surplus metal building stipulated in the project proposal.

* Funds requested in the project proposal.
** Months after authorization.

CAH-848	Geological and Hydrological Wells - FY 1959	$56,600	$4,100	5-6-59	0	0	0	0	5-30-59	7-30-59	- - -	- - -	6-30-59	3-30-60

USING COMPONENT: Chemical Research & Development

FEO ENGINEER: H. E. Ralph

REMARKS:

Directive No. AEC-155, dated May 6, 1959 and Work Authority dated May 11, 1959 approved funds in the amount of $4,100. Specifications for the bid package are being prepared.

CGH-860	Access for PRTR Fuel Elements - 327 Building	$81,000	None	None	0	0	0	0	1/2 *	2 1/2 *	- - -	- - -	3 *	10 *

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

The project proposal was submitted to Contract Accounting May 26, 1959.

* Months after authorization.

AM-7300-019 (5-58)

1240469

UNCLASSIFIED

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - [illegible]

MONTH: May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION — AMOUNT / DATE	PROJECT PROGRESS IN PER CENT — DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE — DESIGN / CONST.	DIRECTIVE COMP. DATE — DESIGN / CONST.	ESTIMATED or Actual COMP. DATE — DESIGN / CONST.
IR-242	Modify 303-J Building to Provide an Interim Test Facility for Fuel Elements	$19,000	$19,000 / 2-17-59	100 / 100	100 / 100	2-17-59 / 2-23-59	- - - / 4-28-59	2-20-59 / 4-28-59
	USING COMPONENT: Reactor & Fuels R & D					FEO ENGINEER: H. E. Ralph		

REMARKS: The Physical Completion Notice is being prepared.

IR-243	Relocation of the 200-E Testing Equipment	$18,000	$18,000 / 3-11-59	100 / 100	99 / 99	3-12-59 / 3-16-59	- - - / 4-22-59	5-22-59 / 6-15-59*
	USING COMPONENT: Laboratory Auxiliaries					FEO ENGINEER: H. Radow		

REMARKS: Relocation of the equipment is almost complete.

IR-246	Alterations to the Positive Ion Accelerator Facility - 3745-B Building	$19,000	$19,000 / 4-20-59	N.S. / 100	10 / 12	4-21-59 / 5-7-59	- - - / 10-20-59	5-1-59 / 10-20-59
	USING COMPONENT: Physics & Instruments R & D					FEO ENGINEER: R. C. Ingersoll		

REMARKS: The concrete footings and floor have been poured. The 440 volt electrical service has been installed, but not energized. Erection of the exterior walls is proceeding.

AM-7300-019 (5-58)

UNCLASSIFIED 0L40471

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - MONTH: May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	DIRECTIVE COMP. DATE: DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE: DESIGN / CONST.
IR-247	Normal Electrical Service - Experimental Animal Farm - 100-F	$12,500	$12,500	N.S.	N.S.	4-29-59	- - -	5-12-59
			4-28-59	100	0	- - -	9-28-59	9-28-59
IR-	Uranium Scrap Burning Facility	$17,500	None	0	0	*	- - -	1 **
			None	0	0	*	- - -	5 **
0084 (AEC-167)	Pickling and Autoclaving Facility for Zirconium Tubes - C-25 Building, White Bluffs	$120,000	$120,000	99	99	3-2-59	- - -	5-15-59
			5-25-59*	99	95	3-19-59	- - -	7-1-59

USING COMPONENT: Biology — FEO ENGINEER: R. C. Ingersoll

REMARKS:

The bid package for lump sum installation of the line work was issued May 19, 1959. The bid opening was held May 29, 1959; apparent low bidder was Duke Electric Company with a bid of $5,562. The Fair Cost Estimate prepared by J. A. Jones Company was for $7,693.

USING COMPONENT: Reactor & Fuels R & D — FEO ENGINEER: R. K. Waldman

REMARKS:

The Informal Request has been prepared and is being circulated for signatures.

* Immediately after authorization.
** Months after authorization.

USING COMPONENT: Laboratory Auxiliaries — FEO ENGINEER: H. Radow

REMARKS:

Installation of all basic items of equipment is nearing completion. Work yet to be done is chiefly piping and electrical hook-up.

* Letter from J. M. Fryar to J. L. Boyd dated May 25, 1959.

AM-7300-819 (5-58)

UNCLASSIFIED

UNCLASSIFIED

BUDGET CLASSIFICATION Improvements to Production and Supporting Facilities - 60-a-1

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - MONTH May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CGH-832	Full Scale Physical Constants Testing Reactor	$915,000	None	None	0	0	0	0	- - -	- - -	- - -	- - -	- - -	- - -

USING COMPONENT: Physics & Instruments R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS: The project proposal requesting $30,000 preliminary design money has not yet been approved by the AEC-Washington.

CGH-859	327 Building Modifications	$350,000	None	None	0	0	0	0	1 *	- - -	- - -	- - -	10 *

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: J. J. Peterson

REMARKS: A project proposal requesting design funds in the amount of $40,000 was submitted to Contract Accounting May 26, 1959.

Equipment Not Included in Construction Projects - Program Class 2900

CG-661	Additional Heat Generation Facility - 189-D Building	$419,000	$664,000	9-18-57	100	100	98	95*	12-6-56	12-3-58	- - -	8-31-59	10-15-58	8-31-59

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: J. J. Peterson

REMARKS: The contractor has essentially completed his work. The ATP is being partially run. Difficulty with the L & N Recorder prohibits checking the sensitivity of the equipment. L & N and General Electric Company (vendor) representatives are meeting to discuss this problem the first part of June; it is hoped it will be resolved.

* Actual percentage is based on re-evaluation including additional work and start-up.

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - MONTH May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CA-681	Hanford Equipment in the ETR	$1,140,000	$1,140,000	4-1-59	95	95	90 *	90 *	9-17-56	4-1-58	- - -	3-1-60	7-15-59	3-1-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

After a series of problems requiring some field modifications the 6 x 9 insertion was finally completed satisfactorily. A slug rupture occurred in the 3 x 3 loop, but was removed without too much difficulty with the HLO designed removal equipment. The 3 x 3 loop has since been reactivated.

* Based on field completion only.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CG-682	High Level Cut-Off and Examination Cell - 327 Building	$415,275*	$430,000	8-20-57	100	100	100	100	7-18-56	3-27-58	- - -	10-1-58	6-28-57	9-30-58

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: J. J. Peterson

REMARKS:

A vendor for the flexible SS cooling line is still being sought, however, a substitute material will be purchased for temporary use. The hood lifting mechanism has been completed. The fourth mainpulator is approximately 85% complete. The exhaust alarm has been essentially completed, but will not be tested until the cell doors are installed. The photography stage for viewing and photographing elements is in the shop and is 40% complete. The rupture slug canning equipment is in the shop.

* Actual cost.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CA-695	Radio Telemetering Network	$109,078	$109,078	9-23-58	100	100	100	100	2-22-57	7-25-57	4-15-57	2-1-59	5-27-57	2-27-59*

USING COMPONENT: Physics & Instruments R & D

FEO ENGINEER: J. T. Lloyd

REMARKS:

The $900 work order (total funds available) will repair only 9 or 10 of the 14 wind generators. CPD Maintenance has had no success to date in acquiring information, from the vendor, on replacement parts. The AEC has been notified of these developments.

* Project was complete with minor exceptions.

AM-7300-819 (5-58)

UNCLASSIFIED

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BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - [illegible]
MONTH May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE: DESIGN / CONST.	DIRECTIVE COMP. DATE: DESIGN / CONST.	ESTIMATED COMP. DATE: DESIGN / CONST.
CG-785	In-Reactor Studies Equipment - 105-KW Building	$276,000	$276,000 / 12-8-58	33 / 3	0 / 0	1-5-59 / N.S.	- - - / 12-31-60	- - - / 12-31-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS:
The first group of approved drawings have been issued and the first procurement requisition has been submitted for processing.

CGH-801	X-Ray Diffraction Cell - 327 Building	$170,000	$10,000 / 6-7-58	N.S. / 40	0 / 0	6-10-58 / N. S.	- - - / - - -	7-1-59 / 3-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:
Approval of the project proposal for remainder of design and total construction funds submitted to the AEC-HOO November 19, 1958 has not been received.

CGH-805	High Temperature Tensile Testing Cell - 327 Building	$150,000	$150,000 / 2-25-59	98 / 95	0 / 0	8-26-58 / N. S.	- - - / 3-31-60	6-15-59 / 3-31-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:
Design is still slightly behind schedule due to delay in drafting. To date five tracings have been completely approved.

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - [illegible]
MONTH May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN	ESTIMATED OR ACTUAL COMP. DATE CONST.
CGH-834	Modifications and Additions to High Pressure Heat Transfer Apparatus - 189-D Building	$700,000	$700,000	4-8-59	5	10	1	1	4-20-59	4-22-59	- - -	10-15-60	2-9-60	10-15-60
		USING COMPONENT: Reactor & Fuels R & D							FEO ENGINEER: H. Radow					

REMARKS:
Design is progressing favorably. A number of purchase requisitions are in process and some purchase orders have been placed.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN	ESTIMATED OR ACTUAL COMP. DATE CONST.
CGH-838	Fission Product Volatilization Studies Test Facility - 292-T Building	$75,000	$75,000	3-26-59	25	44	0	10	4-9-59	4-16-59	- - -	11-30-59	7-10-59	11-30-59
		USING COMPONENT: Chemical Research & Development							FEO ENGINEER: O. M. Lyso					

REMARKS:
The hot water heater and lead brick have been delivered. Bids on the electronic counters and meters have been evaluated and purchase orders are being prepared. Specifications for all major equipment except manipulators (which are ready pending customer approval) have been submitted. Design on shielded enclosure and junior cave sample train will be completed when manipulators are selected. Fabrication by Construction Operation is in progress on exhaust system, cask car, and encloure base. Service piping modification and electrical design are progress.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN	ESTIMATED OR ACTUAL COMP. DATE CONST.
CGH-857	Physical and Mechanical Properties Testing Cell - 327 Building	$400,000	None	None	0	0	0	0	1 *	- - -	- - -	- - -	14 *	- - -
		USING COMPONENT: Reactor & Fuels R & D							FEO ENGINEER: R. W. Dascenzo					

REMARKS:
A project proposal requesting design funds in the amount of $75,000 was submitted to Contract Accounting May 26, 1959.

* Months after authorization.

AM-7300-019 (5-58)

UNCLASSIFIED

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60505
MONTH May, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED or Actual COMP. DATE DESIGN	ESTIMATED or Actual COMP. DATE CONST.
CGH-858	High Level Utility Cell - 327 Building	$500,000	None	None	0	0	0	0	1 *	- - -	- - -	- - -	12 *	- - -

USING COMPONENT: Reactor & Fuels R & D

FED ENGINEER: R. W. Dascenzo

REMARKS:

A project proposal requesting design funds in the amount of $70,000 was submitted to Contract Accounting May 26, 1959.

* Months after authorization.

USING COMPONENT

FED ENGINEER

REMARKS:

USING COMPONENT

FED ENGINEER

REMARKS:

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
Whitman College Students	5-8-59	Whitman College Walla Walla, Wash.	Learn more about Tech. Information	C.G. Stevenson	No	300, 3760
Students & Professors	5-14-59	Walla Walla College Walla Walla, Wash.	"	"	No	"
HS Science Students	5-22-59	Pendleton High Sch. Pendleton, Ore.	"	S.P. Gydesen	No	"
Paul Berner & Don Tettemore	5-6-59	Star Machinery Co. Seattle, Wash.	To present a hydra-spray paint symposium	L.J. Lucas	No	300, 328
George Penning	5-26 & 5-27	Cincinnati Milling & Grinding Mach., Inc. Los Angeles, Calif.	To confer on machine tools	L.J. Lucas	No	300, 328
Donald R. Hubbard	5-13-59	G.E. Co. X-Ray Dept. San Francisco, Cal.	Discuss X-Ray equipment & installation problems.	R.B. Socky	No	300, 328, 326 3706
Aromond Olson Bill Morgan Dan Jones	5-18-59	Union Carbide & Carbon Chemical Corporation Oak Ridge, Tenn.	To observe the High Level Radiochemistry Facility	R.W. Dascenzo	No	300, 325A

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R.B. Socky	5-8-59	Boeing Air Craft Co. Seattle, Wash.	Disc. non-destructive testing progress on PRTR process tubes.	Robert Booth	No
		U.S. Naval Shipyard Bremerton, Wash.		W.A. Hannah	No
R.B. Socky	5-22-59	University of Wash. Seattle, Wash.	Participate as a panelist in a Non-destructive testing program.	Prof. Blake Mills	No
A.W. Fraser	5-22-59	Univ. of Wash. Seattle, Wash.	Participate as a demonstrator in a Non-destructive testing exposition.	"	No

PROFESSIONAL PLACEMENT AND RELATIONS PRACTICES OPERATION MONTHLY REPORT

GENERAL

At month's end, the staff of the Hanford Laboratories totalled 1234 employees, including 580 exempt and 654 nonexempt employees. There were 497 exempt employees possessing technical degrees, including 286 B.S., 110 M.S. and 101 Ph.D.

TRAINING

The Third Program of the Information and Orientation Series was completed with approximately 80% of the nonexempt Laboratories people attending.

Thirty-nine Laboratories exempt people completed PBM-1.

COMMUNICATIONS

Tours were provided during May for 95 high school students, 80 college science and engineering students and 25 presidents and faculty members of Washington junior colleges.

Radiation Protection Operation provided display material and guides for the Armed Forces Day Open Houses at Larson Air Force Base and Umatilla Ordnance Depot.

EMPLOYEE COMPENSATION

A nonexempt classification - PRTR Technician Grade 24 - was established effective May 1.

At the May meeting of the HLO Suggestion Board four suggestions were approved for awards totalling $120. HLO suggestion awards for the year to date total $935.

A Laboratories employee on educational leave, Jack L. Poe, was awarded a General Electric scholarship for the 1959-60 school year.

HEALTH & SAFETY

Laboratories personnel worked a total of 188,800 man-hours during the month with no disabling injuries. Since September 1, 1956 a total of 6,275,127 man-hours have been completed with no disabling injuries.

The medical treatment frequency for May was 1.58 compared with 1.49 last month.

There were no security violations in the Laboratories in the month of May. The total for the year remains at 16.

PROFESSIONAL PLACEMENT

During May, three Ph.D. offers were extended and six HAPO offers were rejected. One offer by HLO was accepted by a Ph.D. physiologist. To date, there have been ten Ph.D. acceptances and there are currently seven Ph.D. offers open.

The recruiting of BS/MS graduates from the campus is essentially completed for the current recruiting season. The bulk of the new graduates will report on the

1240477

payroll during June and July. To date, a total of 71 acceptances have been received for the Technical Graduate Program.

Eleven experienced BS/MS candidates visited during the month. Eleven offers were extended and 13 acceptances were received. Four graduates of the Advanced Engineering Training Program visited Hanford to discuss employment opportunities. All were impressed with the technical opportunities at Hanford but each has a strong geographic preference for the East.

Three Technical Graduates were added to the Training Program and one permanent placement was effected with 28 remaining on the Program at month's end. One summer junior was also added to the payroll.

Nineteen requisitions were filled during the month. With the receipt of 17 new requisitions, there are currently 44 nonexempt openings for which 28 candidates are in process and 4 transfers are pending, with 12 candidates yet to be procured.

T. G. Marshall

Manager,
Professional Placement
and Relations Practices

TG Marshall:tr

1240479

VISITS TO OTHER INSTALLATIONS

Name	Date of Visit	Company Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data
E.P. Galbraith T.G. Marshall	5-1-59	General Electric Co. Public and Employee Relations Services Communication Op. San Francisco, Calif.	Technical recruiting advertising	R.W. Jackson	None
E.P. Galbraith T.G. Marshall	5-1-59	Hoefer, Dietrich & Brown, Inc. San Francisco, Calif.	Technical recruiting advertising	John Hoefer	
E.P. Galbraith T.G. Marshall	5-1-59	McFarland Advertising Agency San Francisco, Calif.	Technical recruiting advertising	Jean McFarland	
R.H. Scott	5-26 5-27	Argonne National Lab. Chicago, Ill.	To discuss feasible methods of converting uranium waste to oxide, to review plutonium methods, and to attend AEC and Contractor Safety Conf.	F.O. Pancner, W. Bleiler, Arther Shuck, J.G. Schnizlein	None

TABLE II NONEXEMPT EMPLOYMENT

Nonexempt Employment Status	April	May
Requisitions		
At end of month	49	44
Cancelled	4	1
Received during month	27	17
Filled during month	14	19
On hold Status	0	2
Candidates Considered		
Total Applications	75	82

Nonexempt Transfer Requests	April	May
Transfer Requests		
Active cases at end of mo.	69	77
Cancelled	4	1
New	3	11
Transfers effected	3	1

1240480

TABLE III. PROFESSIONAL PERSONNEL PLACEMENT

A - Technical Recruiting Activity - HAPO - September 1, 1958 to Date

		Visits to Richland			Offers*			
	Cases Considered	Invited	Visited	To Visit	Extended	Accepted	Open	On the Roll
Ph.D.	640	188	76	34	47	10	7	9
Exp. BS/MS	439	93	65	2	88	57	5	42
Prog. BS/MS	391	-	-	-	206	71	19	14

*Offer totals include offers open on 9/1/58

Ph.D.	3
Exp. BS/MS	3
Prog. BS/MS	3

B - Technical Recruiting Activity - HLO - September 1, 1958 to Date

		Visits to Richland			Offers**			
	Cases Considered	Invited	Visited	To Visit	Extended	Accepted	Open	On the Roll
Ph.D.	640	188	76	34	35	7	5	6
Exp. BS/MS	364	69	42	1	40	24	2	17

**Offer totals include offers open on 9/1/58

Ph.D.	2
Exp. BS/MS	2

In addition to the above activity, 26 exempt employees have transferred into HLO from other HAPO departments and 19 technical graduates have accepted off-Program placement in HLO to date.

1240481

C - Technical Graduate and Technician Training Program
Month ending May 31, 1959

	TG Program	TT Program
Number Personnel on assignment	28	10
(HAPO Tech Grad Programs.....24		
(West. District E.P..... 4		
Summer Juniors	1	
High School Teachers	0	
	29	10
Distribution of assignments by Depts.		
HLO	11	4
CE&UO	0	0
FPD	3	0
IPD	14	6
CPD	1	0
Distribution of assignments by function		
R&D or Engineering	25	10
Other	4	0

1240482

FINANCIAL OPERATION MONTHLY REPORT
MAY 1959

Personnel

There were no changes during the month.

Activities

GENERAL ACCOUNTING OPERATION

Reconciliation work in connection with the physical inventory of uninstalled cataloged equipment in the custody of Chemical Research and Development Operation is complete. Issuance of a formal report is pending the receipt of a signed missing equipment report for ten items. Two thousand, four hundred and sixty-eight items were physically counted valued at $1,751,803. Ten missing items ($2,973) were not located during the inventory compared to 48 missing items ($22,950) in the FY 1957 inventory. The percentage of missing equipment to total dollar value was 0.17% compared to 1.24% in FY 1957. Eight items valued at $1,636 were added to record as compared to 298 items valued at $109,018 in the FY 1957 inventory.

The physical inventory of shop stock material in the custody of Technical Shop Operation has been rescheduled from June 6, 1959 to July 11, 1959.

The physical inventory of Hot Semiworks uninstalled cataloged equipment was conducted during the month. This equipment is recorded in General Ledger Account 1720 - Plant and Equipment Held for Future Use. A report of results will be issued in June upon completion of the reconciliation.

Work in connection with our program of updating fixed asset records is approximately 85% complete. All 300 Area buildings, installed equipment, other structures and research waste handling facilities have been inventoried and converted to new records. A property disposal request and missing plant and equipment report were prepared and approved for the removal of 48 items valued at $43,224. A comparison of the total recorded 300 Area fixed asset cost to the value of missing items is very favorable (.003%) considering this is the first inventory since the plant appraisal in 1949. HLO test wells (225) were verified with records and a property disposal request will be prepared for 2 wells valued at $4,941. These two wells were covered over during construction and abandoned. Atmospheric Physics buildings and other structures, Radiation Monitoring stations in all areas were inventoried and new records prepared. The last area, 100-F, is currently being inventoried.

Projects CG-758, Ceramic Fuels Development Press and Furnace Additions, 325 Building, and CGH-804 - Ceramic Fuels Press Enclosure, 325 Building, were physically inventoried, unitized, and reports issued.

SS Material inventory dollar balance ($12,564,115) was transferred to Contract and Accounting Operation for accumulation and reporting, effective May 1, 1959. HLO General Accounting will continue to (1) consolidate and issue forecasts for outside and inside diversion of SS Material, (2) assist SS Accountability Operation in preparatory work for witnessed physical inventories of SS Material and (3) provide liaison work between Laboratories personnel and Contract and Accounting

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personnel. Output from Contract and Accounting to HLO General Accounting will consist of three copies of the reconciliation of SS Material General Ledger accounts, the dollar value of material by type and HLO Sections, and any information concerning unusual or large changes in the account balances and current month activity.

In connection with the invitation extended to Biology to participate in Operation Plow Share - Alaska, performing radioecology studies of the environs before and after harbor blasting, an estimated $6,000 of equipment is needed. Approximately $3,500 is required for supporting equipment this fiscal year in order that bulky equipment may be shipped by boat to arrive in Alaska during August the only month the sea is not frozen. It has been determined that this amount can be made available from FY 1959 funds.

Appropriation requests totaling $150,000 received final approval in May.

HLO completed the transfer of General Books to C&AO during May. Effective with May C&AO will prepare the monthly trial balance and detail tabulations of account activities.

COST ACCOUNTING OPERATION

The following changes were made in May in the Hanford Laboratories control budget for FY 1959 and will be reflected on May financial statements:

	Increase (Decrease)
Increase in Plutonium Recycle Program R&D as a result of receiving $200,000 additional funds from AEC and a transfer of $200,000 from the equipment authorization.	$400,000
Increase in Swelling Studies provided by expected underruns in the IPD Maritime Gas Loop.	25,000
Increase in the CPD sponsored Weapons R&D Program.	14,000
Decrease in the CPD sponsored Separations Development Program.	(45,000)
Increase in two US Air Force sponsored programs	
Plutonium Inhalation Studies	24,700
Atmospheric Diffusion Studies	30,000

As a result of the transfer of the Personnel Accounting clerical functions to Contract and Accounting Operation, effective May 1, 1959, the costs associated with the Personnel Accounting functions now performed by Hanford Laboratories will be included in the Financial Operation - General Account (7100). The present Personnel Accounting code, 7130, has been cancelled.

Effort was devoted during the month to obtain a realistic cost closing schedule for June, 1959, which required coordination and integration with the other financial components. As a result, several changes in the original proposal were made which met with the approval of all concerned.

PERSONNEL ACCOUNTING OPERATION

History of overtime, January 1957 through March 1959, by Section for each of the nine calendar quarters was prepared and reviewed for the purpose of control. New control levels were established, effective with the second calendar quarter for 1959 by the Manager - Hanford Laboratories.

Effective April 29, 1959 a representative in each of the HLO buildings in the 300 Area was assigned the responsibility of obtaining from Personnel Accounting, Room #16, 3702 Building, both exempt and non-exempt salary checks. The representatives will distribute pay checks to employees authorized to receive pay checks as indicated on each of the separate bundles of checks.

AUDITING

Field work is nearly complete on the audit of General Accounts and Cash Controls. The audit of Inventory Controls is to start shortly.

PROCEDURES

The work of preparing a functional index of forms is nearly complete. As a result of the work finished to-date, seventy forms have been cancelled as obsolete.

A study of the procedure and records employed by the Plant Library for receiving subscriptions is nearing completion. The prime purpose of this study is to streamline the records and procedures and to eliminate the transmission of written proof of receipt to Accounts Payable and Expediting Operations by establishing auditable records within the Plant Library.

Payroll Statistics

Number of HLO Employee Changes During Month

	Total	Exempt	Non-Exempt
Employees on Payroll at Beginning of Month	1 232	579	653
Additions and Transfers In	32	11	21
Removals and Transfers Out	30	10	20
Employees on Payroll at End of Month	1 234	580	654

Overtime Payments During Month	May	April
Exempt	$ 4 251	$ 4 428
Non-Exempt	12 281	11 583
Total	$16 532	$16 011

Gross Payroll Paid During Month

	May	April
Exempt	$472 058	$469 294
Non-Exempt	297 491	290 911
Total	$769 549	$760 205

Participation in Employee Benefit Plans at Month End

	May		April	
	Number	Percent	Number	Percent
Pension Plan	1 165	99.0	1 177	99.0
Insurance Plan				
Personal Coverage	1 230	99.8	1 229	99.8
Dependent Coverage	846		845	
U.S. Savings Bonds				
Stock Bonus Plan	78	39.3	77	39.3
Savings Plan	92	7.4	90	7.3
Savings and Security Plan	1 036	94.1	1 026	94.0

Insurance Claims	May		April	
	Number	Amount	Number	Amount
Employee Benefits				
Life Insurance	1	$12 963	0	$ -0-
Weekly Sickness and Accident	8	178	8	745
Comprehensive Medical	25	2 903	73	8 291
Dependent Benefits				
Comprehensive Medical	45	7 605	142	11 072
Total	79	$23 649	223	$20 108

Good Neighbor Fund	May	April
Number Participating	827	842
Percent Participating	67.2	68.3

W. Sale
Manager - Finance

W Sale/bk

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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
L. F. Kocher F. Swanberg, Jr.	A Field Air Sampler for Radiological Defense Use, for Monitoring the Spread of Air-borne Contaminants from Atomic Weapons
W. E. Cawley	A Position Read Out System for a Reversible Rotating Shaft
R. G. Wheeler	Use of Unrectified Alternating Current for Electron Beam Melting of Refractory Metals
D. C. Kaulitz	In-Reactor Rupture Mechanism for Irradiated Fuels
J. D. McCormack	A Method for Preparing Deuterium or Tritium Accelerator Targets
R. T. Alleman B. M. Johnson	Conversion of Sodium Nitrate to Sodium Carbonate by Calcination with Sugar
W. L. Lyon	A Pyrochemical Separations Process Applicable to Thorium Oxide Reactor Fuels

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