HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
MARCH, 1957

Compiled By
[redacted] peration Managers

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRELIMINARY REPORT

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TABLE I. HLO-FORCE REPORT AND PERSONNEL STATUS CHANGES

Date March 31, 1957

FORCE REPORT

	At close of month			At beginning of month			Additions		Separations	
	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Exempt	Non-Exempt
Chemical Research and Development	125	92	217	125	93	218	1	2	1	3
Reactor & Fuels Research & Development	138	91	229	139	92	231	1	0	2	1
Physics & Instrument Research & Development	60	25	85	58	25	83	2	0	0	0
Biology	32	42	74	32	42	74	0	1	0	1
Operations Research & Synthesis	11	4	15	11	3	14	0	1	0	0
Radiation Protection	41*	201*	242	40	204	244	1*	1	0	4*
Laboratory Auxiliaries	41	195	236	41	197	238	0	6	0	8
Financial	15	31	46	15	32	47	0	1	0	2
Employee Relations	13	12	25	13	12	25	0	0	0	0
General	1	1	2	1	1	2	0	0	0	0
TOTAL	477	694	1171	475	701	1176	5	12	3	19
Total excluding Internal Transfers	477	694	1171	475	701	1176	4	9	2	16

* 1 Reassignment from Non-Exempt payroll

Composite Separation Rate- -1.537
Separation Rate (based on separations leaving G.E.)- -1.110
Controllable Separation Rate - .170

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TABLE II. PERSONNEL STATUS CHANGES (1)
PROMOTIONS AND TRANSFERS

Date March 31, 1957

Component	PROMOTIONS			EXEMPT TRANSFERS (2)				NON-EXEMPT TRANSFERS	
				To HLO		From HLO			
	Exempt	Non-Exempt to Exempt	Non-Exempt	From Other HAPO	From Other G.E.	To Other HAPO	To Other G. E.	To HLO	From HLO
Chemical	2	0	4	0	0	1	0	0	0
Reactor & Fuels	7	0	2	0	0	0	0	0	0
Physics & Instr.	5	0	1	0	0	0	0	0	0
Biology	1	0	1	0	0	0	0	1	0
Operations Res. & Syn.	0	0	0	0	0	0	0	0	0
Radiation Protection	0	1	1	0	0	0	0	0	0
Laboratory Aux.	0	0	2	0	0	0	0	1	4
Financial	0	0	0	0	0	0	0	0	0
Employee Relations	0	0	1	0	0	0	0	0	0
TOTAL	15	1	12	0	0	1	0	2	4

(1) Data through 3/31/57
(2) Transfers within HLO not included

[redacted]

SUMMARY

Research and Development

Progress in programs supported by the product departments has been generally favorable. Over the fiscal year to date the principal departures from schedule have occurred in off-site development of zirconium process tubes and in irradiation testing of fuel elements, the latter a consequence of delays in activation of the KER test facility.

Plans were formulated in detail and the necessary measures taken to assure that expenditures on all research and development accounts of Hanford Laboratories Operation will be within budgeted limits at the end of the fiscal year.

Plans were developed with the Atomic Energy Commission to reduce the scope of a current study of customer criteria and design criteria for a fuel element test reactor.

1. Reactor and Fuels

A preliminary estimate of the construction cost of the plutonium recycle demonstration reactor, based on the currently incomplete scope design, has exceeded available construction funds. Further reduction of scope and completion of scope design are being carried out preparatory to formulation of a new cost estimate.

A survey of materials for pressure tubing in an organic cooled reactor indicated that M-257 alloy (Al + 7% Al_2O_3) has the greatest potential of those high temperature alloys commercially available with suitable neutron absorption characteristics.

Swaged zirconium-clad, uranium oxide fuel elements of about 0.5" diameter have been made with UO_2 densities exceeding 85% of theoretical employing no heat treatment or annealing operations. A similar process with an intermediate vacuum anneal produced compacted cores with approximately 90% theoretical density.

Use of concentrated plutonium (as wires or thin rods) to take advantage of self-shielding may provide a basis for extending the attainable exposure of Pu spike fuel in a plutonium recycle reactor.

A deliberately defected and water-logged UO_2 tubular fuel element was irradiated one cycle in the MTR without apparent damage to the element. Rapid reactor start-up did not produce any noticeable distortion of the element jacket through rapid steam formation in the wet oxide core.

Approximately 61 feet of aluminum-clad Pu-Al fuel rods and 10 flux monitoring discs of the same alloy were delivered to Physics and Instrument Research and Development Operation in March for PCTR testing.

2. Physics and Instruments

Exponential experiments on enriched I and E slugs, begun last month, were continued. Gain in reactivity upon loss of water was determined to be 128 inhours greater for these slugs than for normal solid slugs.

The reactivity of a large cored element and a seven-rod cluster being considered for the IPR were determined in a 7-1/2 inch lattice in the PCTR. For the cluster, measurements were made with and without water, organic coolant was included in the cored element measurement.

The second experiment in the series to determine safe handling limits for enriched uranium in the separation plant was run in the PCTR.

A core tank for conducting experiments with heavy water moderator was installed in the PCTR and reactor operation was being checked out at month-end in preparation for experiments on the PRPR lattice.

Calculations on the reactor coolant loss problem was begun on the analog computer.

An extensive study of the diffusion and transport of stack effluents in stable atmospheres was completed and a comprehensive report has been prepared.

3. Chemical Research and Development

The G.E. mass spectrometer was converted to employ a thermal emission source. Calibration was initiated by measuring the spectra of lanthanum and uranium.

Basic ammonium fluoride solutions continue to show promise as a dejacketing media for fuels clad in zircalloy. Average zircalloy dissolution rates of 30 mils/hr with negligible attack on uranium resulted from simultaneous exposure to boiling six molar NH_4F. Attack on stainless steel (types 304-L and 347) was approximately 0.5 mils/month with no evidence of pitting.

The feasibility of separating plutonium from Purex 1BP or 2BP solutions with an anion exchange resin appears reasonable. Good decontamination and purification was obtained simultaneously with the production of a 65 g/l plutonium solution.

Studies on the formation of synthetic zeolites (sodium alumino silicate) as a means for permanently fixing fission products continue to be promising. The coating wastes do not always contain enough free caustic to produce gelling; however, additions of sodium hydroxide are satisfactory in obtaining a proper gelation.

Approximately 300 documents were reviewed for their applicability to the Industrial Irradiated Fuels Reprocessing Program.

Two lots of special UO_3 were prepared in the semi-works unit for evaluation by K-25. Five tons were produced by hydrating and dehydrating UO_3 from the production plant continuous calciner and five tons were produced without the usual sulfur addition.

The presence of Np-237 in production plant UO_3 was detected by alpha energy analysis of the residue remaining from TTA extraction.

Further confirmation on the stratification of liquid wastes in ground water zones was obtained. Vertical distribution of radioisotopes in a well in 200 East Area were found to be approximately 1,000-fold greater 30 feet below the ground water level than at the beginning of the ground water zone.

Drilling costs for observation wells were reduced to a new low level of $7.40/ft. Kai-well "hard-red" steel casing will be employed rather than the present Schedule 30 mild steel casing.

4. Biology

The gastrointestinal absorption and skeletal deposition of P^{32} in rats was found to be definitely a function of age - varying from 2% in 1-1/2 year-old animals to 11% in 4-month-old animals.

Plutonium seems to be transported in the blood and excreted in the urine in combination with an unidentified substance which is not a protein. Urine and feces concentrations of plutonium reached peaks at 72 hours after the injection into pigs' lungs of a soluble plutonium solution.

Results on recent work on ruthenium absorption and retention tend to deny earlier work. These disturbing findings are being checked.

Swine fed up to 45 μc I^{131}/day have shown no thyroid damage. Highest total dose is estimated at 8,000 rads. I^{131} thyroid and blood kinetics in pigs were measured.

Twelve per cent of radioactive particles inhaled by mice were retained. After exposure this rapidly decreased to 4% and then increased to 8%. No rational explanation is apparent. $Ru^{106}O_2$ was found to cause a malignant lung tumor in a mouse.

The well-known decrease in iron uptake by whole-body irradiated animals was shown to be partly caused by intestinal damage.

In relative biological effectiveness work inconclusive results are being obtained. This is being ascribed to difficulties in techniques and unreliability of isotope solutions obtained from Oak Ridge.

Chloride ion did not increase I^{131} uptake by plants, but bromide ion did. The effect was less marked than with the iodide ion.

In checking old results, it appears that dichromate is not as toxic to plants as once supposed. In other plant work, it appeared that strontium may be absorbed preferential to calcium - a marked contrast to results obtained in other laboratories.

Technical and Other Services

No radiation incidents involving exposure above permissible limits were reported. One incident, involving facial contamination and potential inhalation of plutonium by a maintenance employee, appeared to be of minor consequence from analysis of first bioassay samples. The employee was administered zirconium citrate as a precautionary measure.

Two cases of plutonium deposition were confirmed during the month. Neither case involved significant deposition. The total number of cases on record to date is 200.

The recent ruptures of cored fuel elements and the consequent release of the noble fission gases around operating reactors has emphasized the radiological problems with these gases. A review of the information available on the hazard of such gases was started to serve as a guide to the Radiation Monitoring Operations in the 100 Areas.

A review of the information available on the effects of discharge of reactor effluent water along the shore of the river was made. Although no clear-cut evidence on this case is available, it appeared that a shoreline discharge at 100-K would increase the concentration of radioactive materials in the 100-D intake by at least a factor of eight over the present concentration. Such an increase would lead to sizeable radiation dosage rates on the dry filter beds and would increase the internal radiation problem in the 100 Areas.

During CY-1956 fission product isotopes in the Columbia River reached 0.6 percent of the off-plant MPC. This is a factor of six increase since CY-1953.

Beta absorption and multi-channel gamma spectrometry have lead to the identification of Mn-54 and Tc-59 not previously found in algae, plankton and insects taken from the Columbia River.

Terrestrial and aquatic animals generally contained twice the contamination of one year ago.

Two per cent reactor effluent increased mortality of whitefish during the warm season. At temperatures below 15° C, they tolerated 8 per cent effluent.

Work in the Radiographic Testing Operation was concentrated on the zirconium process tube program. Tubes are being examined by means of single wall radiographs, eddy current traces, dye penetrant tests and boroscope examination.

Work on Operation Pool proceeded satisfactorily with nearly all of the separate studies required assigned to various Hanford components.

The feasibility of employing a sample inventory plan to estimate the General Stores' stock is being investigated. Such a plan would represent a considerable savings over the expense of a complete physical inventory.

A series of presentations on basic statistical quality control techniques to the employees of the Fuels Preparation Department was very well received and has aroused considerable interest.

Statistical analysis of the results of "run-to-rupture" tests and other pertinent information on rupture rates has resulted in a significant change in the basic parameter used to design such tests.

Supporting Functions

Preparation of the Hanford Laboratories Operation Plant Acquisition and Construction Budget for FY 1959 and Revision to the Budget for FY 1958 was completed and submitted to Relations and Utilities for inclusion in the HAPO budget submission.

1951 participants in the Savings and Stock Bonus Plan received their bonds, common stock and accumulated income during March.

At the end of March the staff of the Hanford Laboratories Operation totalled 1171, including 477 exempt and 694 non-exempt personnel. Of the total exempt employees there were 415 with college degrees and of that number 398 have technical degrees as follows:

BS	MS	PhD
201	101	96

In addition there were 37 non-exempt employees with degrees.

The television program "Inside Hanford" was presented March 6, and included presentations by H. M. Parker, the General Managers of the Product Departments, as well as the General Manager - HAPO. There were many very favorable reactions to this program.

Twelve suggestions were presented to the Suggestion Board with 6 being adopted and representing a total savings of $323.00 and awards of $80.00.

The non-exempt employee outlook continues very favorable with only 4 openings for immediate placement. Technical personnel placement activities continue at a reasonably favorable level in all areas except that of broadly experienced, highly qualified specialists and technical managers.

No grievances were received during the month of March. The Wonacott arbitration case continues unresolved and negotiations are continuing with the Regional Monitors.

Hanford Laboratories personnel worked a total of 190,947 hours with no disabling injuries during March. There were 38 medical treatment injuries with a frequency of 1.98 as compared to 1.73 for the previous month. The frequency for the year to date is 1.74.

All secretaries in HLO have now been placed on the new secretarial plan.

F.W. Albaugh

Acting Manager
HANFORD LABORATORIES

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Statistical Evaluation of Corrosion. Most of the available data on the uniform corrosion of aluminum, including laboratory, loop, and in-reactor data, have been correlated in terms of temperature, power, and pH and reported in HW-44996(1).

Corrosion of Uranium in Organic Coolants. Recent work has demonstrated the reaction between uranium metal and organic compounds at their decomposition temperatures to form uranium carbide. This reaction is assumed to pass through a hydride intermediate step, since the rate of formation of uranium carbide is substantially reduced when hydrogen is vented from the reaction vessel (e.g., the autoclave). Since hydrogen gas can be collected and vented from a recirculating reactor system or loop, the carbiding reaction does not appear to be a severe threat to an organic cooled reactor.

A canned uranium sample with a 1/16-inch diameter hole drilled in the can has been under test in monoisopropyl biphenyl (MIPB) for 56 days at 400 C, with the total pressure maintained below 200 lb/sq in. by periodic venting of the autoclave. Although three charges of MIPB have been decomposed in this time, the sample shows no visible evidence of swelling. In a corresponding test in which the total pressure was allowed to reach 680 lb/sq in., the sample was badly swollen after 17 days.

In a less drastic test a bare uranium sample has been in refluxing MIPB at one atmosphere and 300 C for 81 days. The MIPB is protected by a CO_2 blanket. The MIPB has suffered little if any thermal breakdown, and the uranium piece shows no swelling, spalling, or other evidence of reaction.

Three uranium dioxide pellets were tested in MIPB at 400 C for nine days in a closed system. The maximum pressure was 880 lb/sq in. The pellets were not damaged and the weight changes were within experimental error. A bare uranium piece tested in the same manner (at 400 C) was completely converted to carbide in five days. From these tests, uranium dioxide appears to be stable in MIPB, even above the decomposition temperature of the organic.

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(1) C. Groot and R. E. Wilson, "In-Reactor Corrosion of Aluminum," HW-44996, 2/18/57 (Secret).

Corrosion of a New High Temperature Aluminum Alloy. Preliminary experimental data indicate a new aluminum alloy, A203X, is significantly more resistant to high temperature water (370 C) than any aluminum alloy previously tested. The metal loss per square centimeter was no more than half that of either M400 or M388. Based on periodic weight gain measurements almost all the corrosion of the new alloy occurred in the first three to four days, with very small weight gains thereafter. If the weight gain studies are borne out by further metal loss analysis, this alloy represents a very substantial improvement over the best previous experience. The corrosion rate law for alloy A203X does not appear to be parabolic; may possibly be either logarithmic or inverse logarithmic. If true, this would mean that the weight loss at the end of one year would be very small. More data will establish the time dependence.

The alloy A203X contains 5.5% Ni, 0.3% Fe, and 0.2% Ti. The alloy D-709 which is similar in composition except for the absence of the titanium "grain refiner" corroded in a manner similar to M388 and M400. There is a good possibility the special merit of A203X is in the titanium. Addition of Ti or Zr to M388 or M400 might produce beneficial results, and steps are being taken to procure such made-to-order alloys for testing.

Aluminum Corrosion in Static and Refreshed 363 C Deionized Water. Aluminum corrosion rates have been obtained in both static and refreshed (1 gph) 363 C deionized water in autoclave tests. Rates were found to be greater in the refreshed water by a factor of two. Similar effects have been observed in dynamic ELMO loop experiments when ratios of feed and bleed to aluminum sample area were reduced.

Ceramic Coated Uranium. The coating of uranium with special glasses as described in KAPL-1609 has been accomplished in the laboratory. A few four-inch uranium slugs have been coated with a PbO-SiO_2-Na_2O-CuO glass by firing a ground glass coating at 1100 C in a glowbar furnace. Excessive oxidation of the uranium has prevented the formation of an acceptable coating to date; however, a helium atmosphere annealing furnace, now ready for use, will limit the postfiring oxidation of the uranium by the atmosphere.

Recirculating Autoclave. One of the five-gallon high pressure autoclaves in 314 Building will be equipped with a high pressure canned-rotor pump for recirculation of deionized water in the autoclave at a rate of about 10 gpm through a test section. Fresh water will also be added at the rate of about 5 gal/hr to maintain the water quality and to pressurize the system. Tests are planned in this autoclave to elucidate the effect of fluid velocity on the corrosion rate of aluminum at high temperatures.

Radiometallurgy Examinations

Coaxial Fuel Element Examination (GEH-4-15). A prototype coaxial fuel element designed by the Fuel Element Design Operation was examined radiometallurgically after irradiation at the MTR according to GEH-4-15. The

element consists of two concentric thick-walled uranium tubes with a U-U interface 0.375 inch from the slug axis. Preliminary examination showed that irradiation had not affected the dimensional stability of the element.

1280-Curie Cobalt Source. A 1280-curie cobalt source was measured for gamma intensity and loaded into a cask for the Chemical Research and Development Operation.

Organic Corrosion Studies. Equipment for measuring the corrosion of irradiated uranium metal by organic liquids (e.g., reactor coolants) has been designed and is being fabricated in the technical shops.

Fuel Element Test Reactor

Scoping Studies. The AEC has indicated that work on the scoping of a Hanford Fuel Element Test Reactor should not be continued at the present time. HAPO efforts on the FETR will be reduced to revising the required Hanford fuel element test conditions to bring them up to date and to providing liaison for the FETR. AEC still plans to invite private industry to build an FETR with private funds.

Preliminary engineering data for a Hanford FETR will be assembled to terminate the scoping activities. The scoping studies indicated that a test reactor of 150 to 200 MW capacity could provide the facilities for the Hanford fuel element testing program. The reactor to be scoped would use both heavy water and graphite as moderator. The active zone would have a heavy water moderated center zone and graphite moderated side fringe zones. One hundred and fifty-eight process tubes would be arranged on a 10-inch square lattice. The center nine tube rows would be criss-crossed, with five rows vertical and four rows horizontal, and the remainder of the tubes would be horizontal. The center five tube rows would be in the heavy water moderator. The report summarizing the work completed on the FETR in the past three months will be issued in the near future.

Lattice Studies. Buckling values for FETR lattices (K-type process tubes, H_2O cooled, 10" spacing) have been calculated as follows:

Fuel	Moderator	Buckling, cm^{-2}
Natural U	D_2O	3.25×10^{-4}
Natural U	Graphite	0.73×10^{-4}
0.94% U	Graphite	1.75×10^{-4}
J alloy	Graphite	6.00×10^{-4}

The two natural U bucklings are almost exactly those required for criticality in the D_2O-graphite FETR design. The resulting flux distribution approaches the desired shape sufficiently closely that there is every reason to believe that the additional central peaking required could be achieved with small amounts of enrichment and poisoning at appropriate points, without appreciably reducing the available test space. Other flux distributions and core loadings considered were all less satisfactory. Analysis of the effects of the two materials test facilities on the flux distribution is currently being completed.

Basic Metallurgy Studies

Noble Gas Diffusion. The diffusion and agglomeration of the noble gases, krypton and xenon, produced by fissioning of uranium have resulted in pronounced swelling of irradiated fissionable materials. This swelling appears to be markedly dependent on irradiation temperature and U-235 burnup. Because of the effect of such swelling on fuel elements used in proposed reactors, a basic study of the diffusion rate of these gases in pure metals and alloys either single phase or two phase has been initiated. The effect of a second phase is a very basic interest because of the possibility of this phase acting as a locking site for the gas atoms. Alloys currently under study are Ag-Cu, both single phase and bi-phase which will be compared with pure silver.

Six sets of xenon gas samples collected from Ag-Cu diffusion specimens have been successfully irradiated and analyzed this month. The results show that the diffusion of xenon in Ag-Cu alloys is less than anticipated. The sensitivity of the technique is such that the approximate diffusivity must be determined in order to estimate times of diffusion annealing. Initial evaluation of the results indicates that there is a markedly decreased diffusion rate in the two-phase alloys as compared to pure silver.

In conjunction with the determination of diffusion rates of xenon in silver, the thermal neutron absorption cross section for Xe_{124} was determined. This, to our knowledge, is the first time such a cross section has been reported. Due to the method of irradiating the samples in a neutron flux followed by measurement of activity with a gamma spectrometer, it is relatively simple to determine the thermal neutron absorption cross section. This value was found to be 74.4 barns as reported previously. A report entitled, "Thermal Neutron Absorption Cross Section for Xe_{124}," HW-48728, has been released.

Fast Neutron Damage in Molybdenum and Zirconium. The type and degree of damage introduced in metals and alloys by bombardment with fast neutrons is of great basic interest as well as being of definite practical interest in the selection of structural materials to be utilized in reactors. Molybdenum and zirconium have been selected for a basic study of such fast neutron damage because of their crystal structure and their relatively high recrystallization temperature. In the case of molybdenum it has been possible to remove a majority of the damage revealed by x-ray diffraction by annealing at 700 C. Lower temperature anneals remove incremental portions of damage in a stepwise fashion which is markedly dependent on temperature. These results tend to substantiate the possibility of more than one type of damage occurring since a single type should tend to anneal out at one temperature.

Electrowinning of High Purity Uranium. The effect of trace impurities on the behavior of uranium utilized for irradiation damage experiments is of substantial interest since it is quite possible that trace elements can have markedly beneficial or adverse effects on the properties of irradiated uranium. With this in mind, a study is under way to obtain the purest uranium possible to serve as a bench mark in irradiation damage experiments. Uranium has been electrodeposited from a molten salt ternary that

had been prepared directly by using uranium trioxide (from the 200 Area Separations Operation) as one of the preliminary constituents. The method used is similar to the one cited in previous monthly reports except that uranium trioxide is substituted for uranium dioxide. No apparent change is seen in the deposited uranium.

Optical and Electron Microscopy Studies of Irradiated Metals. Observation and interpretation of the damage introduced in fissionable and non-fissionable metals by neutron irradiation is of great fundamental interest in that such information is essential in the interpretation of the damage mechanisms. Optical and electron microscopy are valuable tools in such studies in detecting differences occurring within grains or at grain boundaries by comparison before and after irradiation.

The study of the effect of reactor irradiation on the microstructure of uranium by microscopic examinations is continuing. Identical areas in replicas of specimens corresponding to the pre-irradiation, post-irradiation, and the re-etched post-irradiation states are being examined by optical and electron microscopy. In general, very little change in grain structure has occurred in the specimens irradiated for two cycles in the MTR at a flux of 10^{13} nv (30 MWD/T). To date no evidence of grain growth, void, or crack formation has been found. Careful examination has, however, revealed isolated instances of widening of pre-existing twin bands and the formation of additional twins as a result of the irradiation history. In addition, some grain boundary precipitation has been detected by electron microscopy. Since the conditions of the irradiation minimized the effect of variables other than fast and thermal neutron damage, the observed microstructural changes can be attributed primarily to the neutron and fission events. The importance of direct experimental evidence of the effect of reactor irradiation on the microstructure of uranium dictates the advisability of additional studies on these specimens. Such studies will include comparisons of x-ray line breadth, hardness, and density.

New Fuel Element Development

Projection Fuel Element Development. Projections attached to fuel elements are designed to concentrically position the fuel element in a process tube. Three different fuel element types with supports have been developed. They are: supports attached to standard "F" process fuel elements, supports for 1.44-inch diameter fuel elements for KER tubes, and supports for 1.8-inch diameter KER fuel elements. Mechanical testing of the support systems is complete and a total of 116 pieces of 1.44-inch diameter fuel elements for KER have been fabricated and are now ready for charging. Three 1.8-inch diameter fuel elements are now being irradiated.

Evaluation of Hot-Pressed Fuel Elements (I&E) From Sylvania Electric Products. The non-destructive portion of the quality tests being applied to the Sylvania I&E eight-inch vacuum hot-pressed fuel elements has been completed. The Testing Methods group applied the ID Sonobond test and found four rejects; there were no rejects in the ID Frost test. Both of these tests are designed to measure the same property, namely, the integrity of the internal jacket system with respect to heat transfer. One positive

reject and five questionable elements were found in the OD Sonobond test. The OD Frost test rejected the element previously rejected by Sonobond and three of the Sonobond doubtfuls and an additional four which had been passed by the Sonobond. Twenty-five rejects and twenty-five acceptable fuel elements from the Dy-Chek test were fusion-welded to check the inspection results. Six of the accepted slugs and twelve of the rejects proved to have bad closures. Thus, it appears that the Dy-Chek test must be improved upon if entirely reliable results are to be obtained. Efforts are being directed toward this end. With respect to nickel thickness, the present lot appears to have a generally thinner layer than was true of the former shipment. This is good from the standpoint of reactivity but calls for a check of its effectiveness as a diffusion barrier. This check, of course, will involve long-term destructive testing. Other destructive tests are currently in progress.

Wafer Fuel Elements. Eighty-two C-size I&E wafer fuel elements have been lead-dip canned for reactor testing. These have not been evaluated, but it is expected that it will be necessary to can a total of about 150 elements to obtain the required 70 acceptable pieces. The canning rate for these elements has been demonstrated at fifty per day, with a canning yield of 90%. The wafers used in making up this test lot are pickled on the inside and outside edges only. This is done to minimize Al-Si wetting of the wafer faces by leaving them coated with oxide. It is felt that the non-wet faces will react much more rapidly in event of water entry, thereby minimize radial swelling as compared with axial extension of a failed element.

Transformation-rate study of thin uranium sections is being carried out in order to determine the optimum heat treatment for wafers. Thin uranium coupons are being beta heat treated and isothermally quenched at various temperatures and times to determine the effects of transformation kinetics on the resulting grain structures. Following the isothermal quench in salt, the coupons are given a rapid brine quench to sub-zero temperatures. Two sets of coupons have been isothermally quenched at 640 C and 600 C, respectively, for times up to 10,000 seconds (2.78 hours) and "R_A" hardness measurements taken. Hardness curves with a total range of about 10 hardness numbers and a range of from one to three numbers per point have been plotted. Examination of microstructures is proceeding concurrently.

Hot-Press Fuel Elements. I&E fuel elements that were fabricated for an in-reactor evaluation of the present hot-press process are ready for charging. A mixed charge of solid Hanford hot-press canned and Sylvania hot-press canned fuel elements has been exposed to the corrosion environment of the 314-flow tube set-up. After approximately 184 days in the 100 C water flowing at approximately 12 gpm, one of the Sylvania pieces failed. It appeared to be a side failure. At that time none of the Hanford pieces had failed and no additional failures of either type have occurred after 200 days total exposure. Calculated corrosion rates of aluminum in the 314-flow tubes are about four times that of aluminum in 100 Area process water.

Point Closure Fuel Elements. Fuel elements fabricated for an in-reactor evaluation using the point-closure technique of canning is under way. These elements will be unbonded and will utilize a thin nickel diffusion barrier between the uranium and the aluminum. Tooling is complete and preliminary process tests have begun. The test elements will be fabricated in April.

Welding Development. A welding process is being developed which makes controlled fusion welding in a high vacuum possible. This process uses a concentrated beam of electrons to heat the work pieces to the melting temperature. Limited work has been done with Zircaloy-2 and stainless steel. The results to date have been excellent and a continuing program is under way to evaluate this process.

In the investigation of the roto-arc welding process, emphasis has been placed on the redesign of the present welding unit so as to improve both the magnetic circuit and the inert gas shielding. With the new unit it should be possible to produce a more stable arc-path and result in a reduced flow of inert gas; it is anticipated that the quality of the welds will improve. Several of the weld defects have been analyzed and remedies suggested. The shorting of the electrode through its center has a two-fold cause, first due to the deposition of aluminum on the insulator plate; and second, due to the spacing of the magnetic concentrator with respect to the electrode. The uneven weld zone was attributed to the lateral spacing of the electrode with the work and was corrected by pre-aligning the electrode and work before welding. Deterioration of the electrode material was investigated, from which it was found that the molybdenum electrode deteriorated due to melting of the tip, forming ragged edges which produced localized hot-spots in the weld zone. The tantalum electrode formed a low-melting alloy with the aluminum vapor which tended to bridge the gap between the electrode and the work. A study of the decay current cycle and its effect on the surface of the weld zone has shown that maximum cleaning occurs between one and three seconds and that any extension beyond this tends to produce a dull and porous surface. A detailed investigation of the weld-zone melting during the welding cycle indicated that the Al-Si boiled out of the braze layer prior to the melting of the cap and can, and that the concentration of silicon in the weld zone would vary inversely with the welding time.

Four-Rod Cluster Fuel Testing. Cluster fuel elements are being studied in the search for an extended surface element which will permit plutonium production at high specific powers in a pressurized recirculating reactor. A four-rod cluster element was charged in the Hanford Fuel Element Testing Facility at the MTR on March 13. This fuel element is similar to the two four-rod stainless steel clad elements previously irradiated at Hanford H-Reactor. At last observation it was operating satisfactorily, at a heat output of 46 kw/ft. Calculations based on Hanford 305 Pile data had predicted heat output of 56 kw/ft. The irradiation will be continued for at least three MTR cycles, thus achieving an exposure of about 700 MWD/T.

The cluster fuel element developed for irradiation in ribbed tubes utilized an internal ring to space the four individual rods. Because of the use of non-ribbed tubes in the KER loops, this design has been modified by the

addition of spring clips to center the element within the tube. Ex-reactor pressure drop testing and charge-discharge experiments have been completed for the modified element. Pressure drop characteristics were satisfactory and charge-discharge tests were successful. Tear tests of the spring clips resulted in base metal failure rather than weld zone failure. The first charge of modified elements for the KER charging have been completed. The first irradiation in KER will begin about May 1. Calculations have been made for a test of the KER element in the Hanford ETR 3 X 3 loop. In this facility the element should operate at about 100 kw/ft. The coolant for the test will be 270-300 C water.

Seven-Rod Cluster Fuel Element. A basket assembly containing seven-rod cluster fuel elements was charged into a KE through-hole facility March 1, 1957, under Production Test IP-46-A. This test is part of a program to develop a fuel element capable of performing satisfactorily at high operating temperatures, high specific power, and high burnup. Prior to charging, a 305 in-reactor test was performed. Results of this test(1) showed a power generation for the cluster of 1.086 relative to the adjacent solid column. The accuracy of the relative power generation estimate is limited by the difference in temperatures between the test reactor and 100-KE Reactor. Using data from the above experiment, the seven-rod cluster fuel element has received 200 MWD/T exposure and is currently operating at 60 kw/ft. It is estimated that the basket assembly will be discharged in June 1957, after sustaining a burnup of 600 MWD/T.

Coaxial Tube Fuel Element. Coaxial fuel elements are of interest for HAPO reactor application because they offer promise of having the increased split failure resistance of the larger inner diameter cored element without the accompanying reactivity deficiency. The irradiation of a coaxial tube fuel element was carried out in the MTR during January. The specimen parameters were selected so that the inner uranium tube would operate in the low gamma phase and the outer tube would operate in the alpha phase, based on ex-reactor measurements of the uranium-uranium interface thermal conductance. The specimen has been returned to the Radiometallurgy Laboratory for detailed examination aimed at determining (a) what dimensional changes, internal and external, may have occurred, and (b) what the temperature distribution was within the element. The examination to date has revealed only that the external dimensions have not changed.

Insulated Slugs. Insulated fuel elements in which the uranium fuel operates at high surface and central temperatures may prove to be resistant to thermal stress failure. Three cored insulated elements are being irradiated in the KW-3674 through-hole. The slugs are operating at about 49 kw/ft, and have reached an exposure of 400 MWD/T. Goal exposure for the test is 600 MWD/T. A design document for irradiation of solid insulated elements has been drafted. At the anticipated power of 53 kw/ft, an element containing 0.001 inch of anodized insulation will operate at a surface temperature of 400 C and maximum central temperature of 850 C. No operating hazard greater than that which now exists for the cored insulated fuel element is anticipated.

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(1) Fitch, C. E., "Relative Power Generation of a Seven-Rod Cluster Fuel Element in the KER Loop," HW-48844, 2/4/57.

Co-extrusion of Uranium and Zircaloy-2. Zircaloy-2 can be bonded directly to uranium by thermal and mechanical treatment. Co-extrusion is being investigated as a method of producing Zr-2 clad bonded fuel rod with high integrity end closures. Nuclear Metals, Inc., have produced twelve co-extrusions in the initial investigation of extrusion variables. Since the end closure is produced by deformation of a Zr plug, the uranium-Zircaloy interface is not planar. Stringers of uranium may extend into the Zircaloy area as far as three inches. Reduction of this stringering is a major objective in the development work. The preliminary tests show promise of development of techniques that will reduce this effect to less than one inch.

Fuel Elements for Organic Coolant. At the operating temperatures obtainable in a recirculating reactor using organic coolant, an aluminum-clad, Al-Si bonded fuel element would fail by diffusion of uranium into the clad. New material combinations are being investigated for use in these coolants. Uranium samples clad in aluminum, magnesium, iron, and brass are being exposed in 380 C MIPB in an autoclave for evaluation of corrosion resistance, mechanical behavior, and the effect of pyrolitic hydrogen on the clad and uranium core. Magnesium is a possible clad for use in organic. In the search for methods of bonding magnesium to uranium, test coupons of magnesium were bonded to Al-Si coated uranium by roll cladding at 400 C. The coupons were sealed in quartz and heat treated at 400 C to determine the thermal stability of the bond. During this treatment excessive sublimation of the magnesium occurred, and a thick brittle compound layer that appeared to be Mg_2Si was formed. It appears that a better bond might be formed with uranium coated only with a uranium-aluminum compound rather than Al-Si.

U-Mg Matrix Fuel. U-Mg fuel material is being studied as a candidate for high exposure use, particularly in organic coolant. A HAPO-size U-Mg element canned in aluminum was irradiated one cycle in the Hanford Fuel Element Testing Facility at the Materials Testing Reactor. The fuel element increased 0.025 inch in diameter and 0.009 inch in length. Calculations indicate this change required a 4 v/o expansion of the fuel material. The fuel contained 35 v/o uranium (enriched to 1.75 a/o U-235) in a matrix of Mg-1.5 w/o Si. The element operated at about 100 kw/ft, and the contained uranium accumulated an exposure of about 800 MWD/T. Contact between clad and core was still intimate after irradiation, and there was no evidence of porosity in the fuel. No evidence of the mechanism of growth has been obtained. A similar element was baked in a furnace at 400 C to observe its dimensional behavior, but reaction between uranium of the fuel material and the aluminum clad prevented accurate measurements. Similar tests will be made with a magnesium clad U-Mg element.

Fuel Element Design Handbook. Plans are being made for the preparation of a handbook of fuel element design to be written by members of Reactor and Fuels Research and Development Operation. The handbook is to contain pertinent data, methods, and philosophies of fuel element design so that it may be useful to reactor and fuel design personnel and also serve as an educational tool for inexperienced personnel. An outline has been

written preparatory to determining breadth and depth of coverage and to making writing assignments. It is planned that the handbook will be ready for issuance by July 1, and that it will be published in a form such that revisions and additions can be made with a minimum of effort.

2. REACTOR PROGRAM

Coolant Systems Development

Single Pass Coolant Development. A 1706 mock-up test has been designed to determine whether accelerated tube and slug jacket corrosion attack will result from air addition. The primary concern is the downstream flow surfaces where elevated temperatures will cause the air to come out of solution. In the test, air is injected in the 1706 pump suction through a rotameter, the water is pumped through a steam heated mock-up tube (outlet temperature 115 C), and periodic examinations of the tube and slug jackets are made.

KER Activities. In-reactor recirculation in one 1706-KER loop was initiated at 850 psig and low temperature (~100 C) using an aluminum dummy tube charge. Failure of a canned motor pump bearing occurred after two weeks of operation. Repair or replacement of the pump is now under way. Prior to this incident the system functioned smoothly and excellent control of process variables by automatic instrumentation was obtained. Activity build-up and water quality control were followed closely and appeared to follow predicted patterns.

Organic Coolant Technology. Study of the radiolytic decomposition of MIPB continued in the in-reactor organic test loop. By bleed-off and make-up the material is cycled in the range 30-50 per cent tar; the eighth cycle is now in progress. For a given percentage of tar, viscosity of the fluid increases with each cycle. This effect appears to equilibrate after about seven cycles.

Specific thermal decomposition rates of irradiated and unirradiated MIPB are being measured in the range 400-450 C. Results to date indicate no significant difference in pyrolysis rates of the two materials. The threshold temperature for rapid pyrolytic decomposition has been determined to be in the range 425-450 C. Tests are continuing in order to establish the break point more precisely.

Thermal and Hydraulic Studies

Hydraulic Demand Characteristics of Process Tubes. A report was issued concerning the relationship between flow and pressure drop in reactor process tubes. Data are presented for C, D, H, and KW Reactors and show the effect of outlet water temperature and tube corrosion on the hydraulic demand characteristics.

Air Injection Studies. Injection of air into the suction lines of new Project 558 190 high lift pumps has been proposed as one means to overcome the severe cavitation problems recently encountered. A laboratory

study was made of the effects on pressure and temperatures within a conventional process tube should air be injected into the suction side of the water supply pumps. Nitrogen gas was injected into the front header of both the electrically heated process tube mockup and the hydraulic flow mockup. A small decrease in flow resulted in the venturi zone tube at an outlet water temperature of 100 C due to a slight pressure buildup at the rear fittings. By using a glass section in the hydraulic apparatus it was observed that the nitrogen gas bubbles were well dispersed around the annulus and moved with approximately the same velocity as the water.

Boiling Burnout Studies. Twenty-three more boiling burnout determinations were made on the high pressure heat transfer apparatus at a variety of pressures and heat fluxes. This brings the total number of burnout runs using a uniform heated rod in a horizontal test section to approximately 60. The design of a vertical test section is nearly complete and construction has started.

Shielding Studies

Attenuation Characteristics of Ordinary Concrete. Curing of the set of shielding slabs made of ordinary concrete for use in the DR shield test well was completed. These test slabs are scheduled to be placed in the test well during the next scheduled outage of DR Reactor.

Neutron Dosimeter. The calibration of the neutron dosimeter has been completed and new operating conditions specified for greater stability. The old calibration was found to be in error, probably because of the steel used in the moderator shell. This requires that a constant correction be applied to all previous measurements.

A neutron source in a paraffin cask has been calibrated against a standard so that field calibration of the dosimeter will be possible by merely placing the BF_3 counter tube in a hole in the cask.

A new dosimeter has been ordered (using aluminum construction) which will have a double moderator. One moderator will measure dose; the other will measure flux. Then the ratio will allow calculation of the average neutron energy wherever measurements are taken.

Irradiation Testing. The monthly status report, "Status of Production Tests of Special Interest to Hanford Laboratories Operation - March 15, 1957," HW-49136, was issued. The irradiation test of three seven-rod cluster fuel elements in the 3865-KE front-to-rear test hole was started March 1, 1957. The cluster fuel elements are operating at 59.5 kw/ft. A fuel element failure occurred in the test to determine relative corrosion characteristics of M-329 and M-388 jacketed fuel elements. The M-329 jacketed element failed at 117 MWD/T. Irradiation tests to evaluate vacuum canned fuel elements and hot-press canned fuel elements have been proposed by Fuels Fabrication Development Operation.

Mechanical Equipment Development

Test Facilities. The storage tank-pressurizing vessel for the mechanical organic test system has been fabricated. Radiographic inspection of the vessel revealed three small weld defects. These defects will be corrected and the vessel subjected to another hydrostatic test. Arrangements are being made for "Third Party Inspection" in compliance with the ASME codes. Fabrication of the test facility's main piping continued.

The preliminary scoping of the high-pressure, high-temperature recirculating water facility for mechanical component tests was completed. This facility operating at a maximum temperature of 630 F and 2400 psi will provide both thermocycle and thermoshock tests.

Nonmetallic Materials Development

Graphite Thermal Annealing - Cooled Test Hole Series. Analysis of data from this series has clarified the manner in which radiation damage in graphite is distributed among the various activation energies. This will aid in predicting the damage to graphite exposed at low temperature (e.g., in the fringe zones) in the Hanford reactors. A similar test series on graphite exposed at about 425 C is also under way.

Thermal annealing of the low temperature radiation-damaged samples has been carried out to 1620 C. This corresponds to an approximate activation energy of 158 kcal/g-atom. Temperature measurement and control was accomplished with an optical pyrometer when the Pt, Pt-Rd thermocouple failed at 1460 C. Sample length changes for a few of the anneals are presented in the following table.

Sample Exposure MWD/CT	Per Cent Change in Sample Length			
	No Anneal	After 50 kcal/g-atom*	After 100 kcal/g-atom*	After 145 kcal/g-atom*
416	0.198	0.121	- 0.030	- 0.032
604	0.323	0.238	0.008	- 0.035
764	0.457	0.341	0.070	0.022
1216	0.595	0.458	0.124	0.022
1640	0.805	0.716	0.304	0.019
2160	1.720	1.480	0.619	0.037
5723	2.918	2.841	2.288	1.180

*Note: Thermal activation energy for the annealing.

C_o expansion has annealed in a similar manner; however, no C_o values less than the virgin values have been observed. The samples with the smallest amount of damage now have C_o values which are leveling off at about 6.72 Å. Measurements of L_c crystallite thickness transverse to the layer planes were erratic for highly damaged samples but, following the high temperature anneals, are now approaching initial values.

Effect of Compounding Ingredients on Radiation Resistance of Organic Polymers. Variations in the compounding of neoprene and nitrile types of elastomers have a pronounced effect on their radiation resistance. For example, by the use of different reinforcing and stabilizing agents, a Type W neoprene elastomer was irradiated to 3×10^8 r before breaking in a standard flexibility test, while a differently compounded Type W neoprene broke after 3×10^7 r. The common practice is to emphasize the polymer type in classifying materials as to radiation stability. Recent results have shown that the additives and method of compounding must be considered before predictions or classifications can be attempted. Since there are literally dozens of such additives used commercially, future tests will attempt to classify those most useful in imparting radiation resistance.

Graphite Stored Energy. The results of samples irradiated under PT-403 (controlled temperature irradiation of graphite) show the stored energy content to be a sensitive function of irradiation temperature, as indicated below:

Exposure, MWD/CT	Irrad. Temp., °C	Stored Energy, Cal/Gram	Stored Energy for a Comparable Exposure at 30 C, Cal/Gram
464	213	7.4	206
1135	135	83.7	435
1135	137	93	435
1135	123	119	435
1135	118	132.4	435

Stored energy determinations are being made on samples irradiated at 425 C.

Thermocouple Testing. Tests at 600 C and 800 C are continuing on 20-gauge chromel-alumel thermocouples with a stainless steel sheath and magnesium oxide insulation. Following one month's operation in a pure carbon dioxide atmosphere the thermocouples dropped two to three degrees C at 600 C and 25 degrees C at 800 C. More thermocouples of this type are being prepared and examined for tests in 50 per cent helium, 50 per cent carbon dioxide.

Structural Materials Development

Zirconium Alloy Development. Analyses of the factors that may have contributed to the tube reducing mandrel breakage at Superior Tube Company during their February operations were discussed with Superior Tube Company personnel. A revised mandrel design, which it is expected will minimize the undesirable features of the previous design, is being prepared by the Superior Tube Company. All parts are on hand at Superior Tube Company for the modification (lengthening) of the tube reducing machine, as required for the fabrication of 48-foot long tubes. The modification of the building has been completed and new concrete footings for the machine have been poured.

Seven short lengths of ribbed Zircaloy-2 tubing, ranging from [redacted] feet to 16 feet in length, were received from Superior, and two short lengths of ribbed Zircaloy-3 tubing (total, approximately 21 feet) were received from Allegheny Ludlum Steel Corporation. These short lengths are currently being inspected by the Radiographic Testing Operation.

An attempt to tube reduce B-D-F Zircaloy-3 ribbed tubes to final size on March 23, at Tube Reducing Corporation as a part of the work on Contract DDR-6 with Allegheny Ludlum, was unsuccessful because of material failures in the form of fractures across the ribs similar to those previously experienced by Superior Tube Company. An analysis of a partially tube reduced section indicates that the reduction of area of the rib section was substantially less than the reduction of the tube wall; a condition known to cause failure of the ribs. The mandrel design is being corrected to eliminate this difficulty. One short piece and ten full length pieces remain to be tube reduced to final dimensions.

The two full length ribless KER Zircaloy-2 tubes which were received from Bridgeport Brass Company were examined by Radiographic Testing Corporation. A lap or fold, approximately 18 inches long, was found about five feet from one end of one tube. The other tube appears to be sound and will be more thoroughly inspected.

The need for a program to develop fabrication techniques for KER type, Zircaloy-2 process tubes was emphasized by the failure of either Allegheny Ludlum or Bridgeport Brass to produce acceptable tubing using techniques currently available. Consequently, Contract DDR-11 has been negotiated with Allegheny Ludlum Steel Corporation to determine the amount of cold work permissible when fabricating Zircaloy-2 in a shape similar to the KER tube. Upon completion of this contract it is expected that the design of a metallurgically sound fabricating process will be possible.

Previous testing of Zircaloy at Hanford (HW-44906, HW-40312) has shown that the increase in strength of Zircaloy brought about by cold working the material on the order of 50 per cent is rapidly lost at moderately elevated temperatures (e.g., 400 C). This phenomenon, called "flow stress recovery" or just "recovery" of the material, results in the yield and tensile strengths of the material falling off to approach the fully-annealed values. Consequently, the design of Zircaloy components for service at moderate temperatures (e.g., reactor pressure tubes at 350 to 400 C) should not be based on the assumption of the higher strength values resulting from high degrees of cold working. However, results of current tests indicate that some strength advantage at elevated temperatures may be derived by using Zircaloy-2 pressure tubing with a low per cent of cold work. Extrapolation of preliminary data for 15 per cent cold-worked Zircaloy-2 indicates that after 10 years at 350 C a yield strength of about 52,000 psi may be expected (compared with a maximum yield strength of approximately 46,000 psi for fully annealed Zircaloy-2 specimens). Based on extrapolation of similar preliminary data, 25 per cent cold worked Zircaloy-2 does not appear to exhibit a greater "permanent" yield strength than the 15 per cent cold worked material, for high temperature service.

Aluminum Alloy Development. A comparison of the properties of aluminum, magnesium, steel, and zirconium alloys indicates that aluminum-Al_2O_3 alloy, M-257, has the greatest potential for use as pressure tubing in an organic cooled reactor operating in the range of 250 to 450 C. The bases for this conclusion are discussed in document HW-49029. To provide adequate data for the design of M-257 pressure tubing, the creep testing program at the University of California is being extended to include tests at 260 and 343 C.

Alcoa has completed the experimental fabrication of twelve B-D-F size ribless, M-257 process tubes. Development of tooling to fabricate ribbed M-257 tubing is continuing. All but the final drawing operation was completed on five KER-size, ribless M-257 tubes.

B. WEAPONS - 3000 PROGRAM

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

C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels

All of the Pu-Al fuel rods cast for PCTR testing have been machined and cut to length as required for the fuel element assemblies. Approximately sixty-one feet of the fuel rod was machined, inspected, and weighed preparatory to canning. Ten flux monitoring wafers 0.010 inch thick were cut from the rods. Radiographs showed a minimum of internal shrinkage voids and the average plutonium composition, by chemical analysis, was 1.80 w/o plutonium with an average maximum and minimum of 1.82 w/o plutonium at the bottom of the castings and 1.79 w/o plutonium at the tops.

A technique was developed whereby the fuel rods were successfully jacketed without external surface contamination on the canned fuel elements. A small amount of powdered graphite was applied to the rods to prevent galling during assembly. The end caps were heli-arc welded into the aluminum cans and the flux monitoring discs were clad with five-mil aluminum cans which were sealed by soldering. Each finished assembly was tested for leaks with a bubble tester. Components for the Zircaloy clad test assemblies are being prepared for assembly and final closure.

A sample of one of the Pu-Al alloy rods with freshly machined surfaces was easily cleaned with alcohol in an open front hood to the point where no smearable contamination could be detected. Also, no smearable contamination has been detected after a storage period of two weeks.

Calculations made for 1/2-inch diameter capsules of Al-1.67 w/o Pu, clad in 0.030-inch Zircaloy jackets indicate that under MTR operating conditions a volumetric power generation twice that expected in the PRP will give a maximum core temperature of about 400 C. Two capsules of this type are planned to commence irradiation in the MTR on about May 1, 1957. Calculations are in progress to determine probable MTR operating characteristics to facilitate the design and fabrication of zirconium-clad, mixed crystal oxides (PuO_2-UO_2) capsules of various densities and compositions.

The Savannah River request for 100 Al-10 w/o Pu wafers and one Pu-Al slug to be delivered in April is being fabricated. The foil for the wafers has been rolled to size and the wafers have been punched out. Also, the 0.002-inch nickel cans for these pieces have been fabricated. The mold is being fabricated for casting the slug.

UO_2 Fuels Development

PCTR Fuel Elements. Fabrication and testing of aluminum-clad uranium oxide fuel elements for PCTR tests planned by Experimental Nuclear Physics Operation in support of the Plutonium Recycle Program were completed. One hundred and fourteen outer buffer rods (34-1/8 inches length), thirty-eight end buffer rods (8-3/8 inches length), nineteen sealed and five demountable test rods (16-3/8 inches length) were assembled. These elements contain sintered and ground UO_2 pellets having an average density of 10.2 ± 0.1 grams per cubic centimeter. Following final assembly an anti-corrosion coating was applied to the fuel elements by boiling six hours in distilled water. The elements were individually helium leak tested.

Defected UO_2 Fuel Element - GEH-4F. One purposely defected, internally and externally cooled, UO_2 fuel element was irradiated in the GEH-4 facility of the MTR without unusual incident. The purpose of the experiment was to determine the effect of rapid reactor startup on a waterlogged, defective UO_2 fuel element. The element consisted of an UO_2 core 1.410 inches OD, 0.475 inch ID, 4.0 inches long, clad in Zircaloy having an inner wall thickness of 0.035 inch and an outer wall thickness of 0.020 inch. The outer wall was pierced at approximately the mid-point with a 0.014 inch diameter hole. The void space within the element was completely filled with water. The MTR was raised very rapidly to the requested power (from critical to twenty megawatts in seven minutes). No variation in coolant pressure drop was observed, indicating no distortion of the cladding due to steam burst. The maximum core temperature was calculated to be 1040 C. The rise of radioactivity of the facility discharge water roughly paralleled the rise of reactor power. The activity of discharge water from the waste tank, measured at one inch distance, was 23 mr/hr/pint. The composite half-life of the activity was 32-1/2 minutes. The effluent radioactivity dropped rapidly to near zero immediately upon reactor shutdown.

Exposure of UO_2 to Organic Coolants. Three cold pressed and sintered UO_2 pellets of the type fabricated for the PCTR fuel elements were corrosion tested in monoisopropyl biphenyl. One unground pellet and two surface ground pellets of 89% and 95% of theoretical density were exposed to 400 C

MIPB for 216 hours in a static, sealed autoclave. No measurable weight change and no change in physical appearance of the UO_2 was apparent. Under identical conditions less than 120 hours exposure is known to be sufficient to convert uranium metal to uranium carbide, en toto.

UO_2 Fabrication Studies. The characteristics of UO_2 powders obtained from various sources are being determined and correlated with fabrication behavior. The following conclusions have been reached with respect to pressed and extruded UO_2 pellets:

(1) Sintered densities increased with increasing surface areas.
(2) High density extruded rods are most likely obtainable with Ceramic Grade UO_2 of high surface area, micronized PWR UO_2, or PWR UO_2 treated by an oxidation-reduction process in a fluidized bed.
(3) Hanford depleted UO_2 compared favorably with other UO_2 powders.
(4) The oxidation-reduction treatment of powders appears in general to provide a promising method of powder preparation, prior to compaction and sintering.
(5) Micronized PWR Grade UO_2 sintered to over four per cent higher density than any other powders tested.

Additional work is planned to further determine the effects of various treatments on UO_2 powder characteristics and fabrication behavior and to compare the economics of the various processes.

Detailed Design of Tubular Fuel Elements. Preliminary design of end closure sections and end fitting hangers for the tubular fuel element was completed and some of these sections are being fabricated. Detailed design and fabrication of full-scale mock-up fuel element assemblies are scheduled to begin in April.

Swaged UO_2. Zircaloy clad UO_2 fuel elements have been made with 64% reduction in cross-sectional area. A 5/8-inch OD x 0.050-inch wall, 1/8th hard Zircaloy tubing was used. This tube, after being filled with UO_2 plus 1/10% uranium powder, was cold swaged to 3/8-inch OD. No intermediate heat treatments or annealing operations were used. The finished tube upon examination was completely free of any defects which might be caused by excessive cold working. The final wall thickness was approximately 0.040 inch and the final oxide density was 85.5% of theoretical. Fuel elements produced in this same manner with the exception that they were vacuum annealed at 750 C at approximately the half-way mark, resulted in densities approximately 90% of theoretical. However, Zircaloy-2 cladding on this element did not appear to have a better finish or be superior in any way to the elements produced without the intermediate anneal.

Etching of Ceramics and Cermets. A valuable tool for interpreting the properties of ceramic materials is the grain size obtained during sintering. This will vary widely with particle size, sintering times, and temperature. In most instances it has been impossible to exploit these

microstructural studies because of the inability to etch such ceramic materials. Studies are currently under way to establish the applicability of cathodic vacuum etching for such purposes.

Mechanical Equipment Development

The detailed design and the specifications for the 314 Building PRPR Process Tube Test Shaft were approved by the Hanford Operations Office of the Atomic Energy Commission. Contractors have been requested to bid on the contract. It is expected that the contract will be awarded the first week in April.

The final piping arrangement for the PRPR Single Tube Prototype Facility has been completed. Purchase requisitions have been issued for the piping, heat exchangers, pressurizer, make-up tank, and make-up pump. Comments have been submitted on the instrument flow diagram and the instrument panel arrangement. The mechanical sealing arrangement for the prototype recirculating pump has been designed. Construction Engineering Operation is preparing the pump specifications.

Zircaloy-2 tubing (2.5" OD c 1/4 wall thickness) has been received for use in testing the inlet process tube fittings. Fabrication has started on a test section containing two proposed types of fittings.

The Johnson Pump Company, Byron Jackson Pump Company, Peerless Pump Company, Harvey Aluminum Company, Paddock Engineering Company, and American Locomotive Company were visited this month for engineering consultation on various PRPR components. The following subjects were discussed: pumps and mechanical shaft sealing arrangements, aluminum usage, filters, and heat exchangers. A trip report will be issued and distributed to interested parties.

Coolant Systems Development

The PRPR vertical tube flow and corrosion testing prototype was completed and shakedown testing is under way. The facility provides 150 GPM of 600 F water to a stainless steel tube of PRPR geometry. Initial tests in the apparatus will utilize a dummy 19-element fuel cluster to determine long term flow stability characteristics, film deposition patterns, and corrosion effects.

Calculations were performed to determine the feasibility of using aluminum jackets for Pu-Al fuel elements having relatively short exposure periods. It was determined that the use of pH 4.5, phosphate inhibited water would make this a practical approach. Specifically, the total estimated corrosion penetration in a three-month period would be 10 mils for a fuel element surface temperature of 560 F.

A review of decontamination requirements for the PRPR was made. The study showed that primary coolant and moderator systems should be separated to permit effective decontamination of the primary system components, without damage to the aluminum calandria and shroud tubes.

Structural Materials Development

The aluminum components for the PRPR experimental assemblies for PCTR tests were anodized and sealed for members of the Nuclear Physics Research Operation. This anodized film will reduce the aluminum attack in the closed process tube.

Process Tubes. The fabrication of four prototype Zircaloy-2 process tubes for the PRPR was initiated at Chase Brass and Copper Company. The tubes are expected to be delivered in late May or early June. Orders were placed with the LaFiell Manufacturing Company to fabricate the flange and tapered end geometries on short lengths of process tubing prior to attempting these operations on full length tubes.

Sheath Tubes. The Wolverine Tube Company has started fabrication of development quantities of Zircaloy-3 sheath tubing for the 19-rod cluster fuel element and the two small diameter tubes for the nested tubular element. A May 1 delivery date is estimated by Wolverine. The Superior Steel Company started rolling of the Zircaloy-3 strip which will be subsequently formed and welded into tubing for the three large diameter tubes of the nest tubular fuel element. The strip will require about two months to fabricate because of the time delays associated with intermediate vacuum anneals.

Plutonium Fuel Cycle Analyses

Recycle Evaluation. HW-49486, "Preliminary Evaluation of Plutonium Recycle," has been completed and is being published. It is concluded that in this study:

(1) Plutonium can compete economically with U-235 as power reactor fuel and has the potential to surpass it.
(2) A research and development program to improve plutonium technology has attractive pay-off potentialities.
(3) An experimental reactor and associated separations facility is needed in such a program to demonstrate fuel technology, to determine physics constants, and to analyze cycle variables.
(4) Plutonium recycle, as a reactor operating concept, is applicable to all reactor types, especially those with less than 1.5% enrichment and conversion ratios greater than 0.50.
(5) Depleted uranium, such as diffusion plant wastes, has a special profit advantage as feed material for a plutonium recycle power reactor.

Neutron Temperature Studies. A general method of analysis of the equilibrium cycle parameters has been applied to the problem of the effect of neutron temperature on attainable exposures. Preliminary results indicate a decreasing attainable cycle exposure as the temperature rises, at least up to 300 C, at a rate of approximately -0.08% per °C. At higher temperatures the results are uncertain because of their sensitivity to the alpha (capture to fission ratio) of Pu-239, which must be known to high accuracy. Improved cross-section information now available

will be utilized during the next few days to provide more reliable high-temperature predictions.

Fuel cycle equations in linearized form are programmed for the analog computer. Results should be available shortly. Two sample cases, for a 400 MW D_2O reactor with steel-lined process tubes, were earlier calculated by hand. One case, using spike Pu enrichment, yielded the result that with about 28% of the reactor occupied by the Pu-Al spike fuel, a favorable cycle could be maintained at exposures of 5000 MWD/T. The other case, using "uniform" enrichment (recycle of Pu with part of the exposed UO_2) was still more favorable.

Experimental Reactor Design

Scope. Current engineering data for the PRPR were compiled and included in the booklet of scope drawings issued March 11. A justification for construction of the PRPR has been written for the project proposal.

A cost estimate for construction of the PRPR was received and was reviewed by the PRPR design group.

Calandria and Reflector. Calandria design at present is based on the scheme previously denoted as Scheme II, utilizing a two-section reflector tank. The design details of the calandria and reflector which have been developed to this time are shown in drawings SK-1-6255, SK-1-6288, SK-1-6301, and SK-1-6309. Discussions were held with representatives of the Andale Company of Philadelphia, who made three calandria tanks for the Canadian NRX reactor and one for the Canada-India reactor, and with representatives of the Aluminum Company of America. Both companies indicate that the proposed design is feasible. The Alcoa representatives stated that fabrication of the calandria tubing from 6063 aluminum alloy would be feasible, and for the sheet and plate utilized in the structure 5050 or 5052 alloy could possibly be used. All of these alloys are magnesium type alloys, with 5052 containing 0.25% chromium. Special impurity tolerances for undesirable elements in these alloys can be specified. The specification procedure would be similar to present practices for fuel element jackets and process tubes.

Helium System. An engineering flow diagram of the helium system has been

The first draft of the process tube assembly design criteria has been circulated for comment and is being revised. Design Test PR-50, Reactor Piping Seal Testing, has also been issued.

Process Piping and Equipment. Water treatment requirements for the PRPR were reviewed and recommendations were made which will reduce the quantity of water treated from 1200 GPM to 415 GPM. Total water consumption requirements were also reduced from 1200 GPM to 900 GPM.

The D_2O piping system flow diagram (SK-1-6232) was revised to reflect process modifications made to the primary coolant loop.

The evaluation report covering liquid-to-liquid vs. liquid-to-boiling-liquid heat exchanger systems was completed in rough draft form.

Charge-Discharge. The rough draft of document HW-48102, the design criteria for the PRPR charging and discharging equipment, has been reviewed. Nine scope drawings which are to accompany the document are being reviewed to insure agreement with the text of the document.

A simplified redesign of the fueling vehicle is substantially completed. Indications are that this revised design will reduce the cost of the fueling vehicle about $50,000. The design of the balance of the charge-discharge equipment is now being reviewed for possible simplification of design.

Control and Safety Systems. A new shim control system is being designed which shows promise of being considerably less expensive and simpler to construct than the flexible cable and bead system previously considered. The new system will entail a series of solid "half-rods" operated by geared miniature motors. The complete system will be contained within the calandria and the top and bottom shields; each shim unit, including the motor operator, will be constructed of such dimensions that it can be removed by the charge-discharge machine. In this scheme the half-rods will be exposed directly to the moderator rather than being enclosed in dry tubes. This is expected to relax considerably the restrictions previously imposed on poison elements that they generate an absolute minimum of heat during operation.

System volumes are being calculated for the revised calandria and moderator storage tank, and flow equations are being set up preliminary to GEDA computer analysis of the moderator dump and reactor control characteristics.

Reactor Instrumentation. Five scope drawings on various instrumentation systems were issued during the month. Document HW-48101-H, "Reactor Radiation Monitor System Criteria," was issued for comment and review. The criteria for the water activity monitor system and for the reactor thermocouple system have been prepared in rough draft form and will be issued for comment in the near future.

Scope work on reactor instrumentation was continued during the month. Detailed design of instrumentation is expected to start in June.

Reactor Shielding. Four drawings were issued during the month for comment. These are preliminary cross-sections of the top and bottom shields which delineate structural details and the physical location of major items such as piping and shim controls which penetrate the shield.

A test request for determining the relative activation and corrosion properties of carbon steel balls or raushig rings and other types of heavy aggregate was issued for comment. Possible substitutes for the carbon steel aggregates include ferrophosphorus and ferrosilicon.

The Savannah River Plant was visited in order to review the detail construction drawings of the SRP thermal and biological shields and to obtain information on operating problems.

Building and Services. The building process area changes made during the month consist of adding a small four feet diameter by six feet long emergency air lock. The containment shell foundation was changed to reduce the quantity of concrete required.

The building process area remained essentially the same as shown on the drawings in scope booklet, the major change being to enlarge the tunnel section near the storage basin to allow installation of the water treatment equipment in this area which is nearer the process cells.

The rough draft design criteria document, HW-48099, covering the building and services was issued for comments.

Building Ventilation. A design criteria document covering ventilation has been prepared and issued for comment. The criteria were based on the supply of 100% fresh air to all parts of the process area. Drawings are being modified to obtain reductions in cost, the feasibility of which became apparent through cost estimates of several ventilation schemes.

Electrical System. The electrical design criteria document was reviewed and revised during the month. Information was assembled on turbine-generator steam rates and prices and on the frequency of 300 Area power outages during the past five years.

Reactor Physics

Flux Studies. The IBM-650 code, VAL-PROD-I, is now essentially ready to use for PRPR lattice cell and reactor flux distribution calculations. Only minor discrepancies remain in the calculated results, and it is believed that these are the result of small errors in the input cross-sections. The code provides flux distributions in several energy groups (three at present) and should be of great value in the support of the tank, reflector, and shield design program.

Self-Shielding Plutonium Fuel Elements. A study was begun on an economically attractive type of plutonium fuel element, one which employs a highly concentrated form of the element (ideally the pure metal) in a thin wire of the order of 1/8" in diameter, surrounded by 3/16" of

containing sheaths. Due to the fact that neutrons can penetrate only a short distance into such a fuel rod, the rod can contain about five or six times as much plutonium as a dilute Pu fuel rod would contain, without running at a higher power. The attainable exposure is therefore far greater and costs of jacketing, fabrication, and processing are correspondingly much lower than for other types. Two P-3 flux calculations have been carried out which support the earlier estimates of the self-shielding effect. With H_2O cooling, a self-shielded rod at the center of a PRPR UO_2 rod cluster is exposed to only 4.1% of the flux in the moderator, while the UO_2 rods are exposed to between 50% and 60% of the moderator flux. Comparable exposure times for the two types of fuel are thus apparently not difficult to achieve.

D. CUSTOMER WORK

Radiometallurgy Service

Examination of VSR #51 from 100-H Reactor. Vertical Safety Rod No. 51 from 105-H was received for examination to determine the cause of a 12-inch long split located about nine feet from the tip of the rod. This rod had been in operation for 19 months at 100-H reactor and had been exposed to approximately 10^9 Roentgens. The VSR consisted of four-foot long polyethylene cylinders wrapped in 2S aluminum with powdered boron tamped between the aluminum and an outer, chromium-plated steel tube. Examination of the VSR revealed that the original 2-3/8-inch polyethylene core had expanded approximately on the 3/16" diameter, that this expansion had mechanically worked the surrounding 2S aluminum, and that the width of the boron annulus was not uniform. The chromium plating on the outside of the steel tube was in good condition; the average thickness being approximately 0.00004 inch less than the specified thickness of 0.0006 inch. Preliminary metallographic examination has not revealed any original material defects in the region of the split in the tube.

Examination of VSR #55 from 105-KW. The examination of VSR No. 55 from 105-KW was requested by the Irradiations Processing Department to determine the reason for the cyclical pattern of indents along the length of the rod. Preliminary examination of the Type 304 stainless steel tube revealed that the indents were caused by impact with a spherical object and were not caused by corrosion. Hardness values taken in areas of damage were slightly higher (0 to 6 Rockwell B) than in the undamaged areas. Measurements of the indents showed a maximum penetration of 0.03 mm.

Metallography Service

One of the services rendered to the Fuels Preparation Department is the metallographic examination of selected production fuel elements that have failed in the steam autoclaves. Although the objective of these examinations is to elucidate the cause of the failures, this is usually next to impossible because a large, gaping hole is present in the aluminum jacket caused by the reaction of the uranium and the hot water, with the result that the original jacket defect is obliterated. Recently, however, routine inspection of fuel

elements after the autoclave test revealed one with a small hole in the jacket which had not as yet produced catastrophic failure. Metallographic examination of the fuel element showed complete AlSi penetration of the aluminum can wall associated with a defective jacket in the area of the pinhole. This was the first clear-cut instance in which such a failure could definitely be connected with a specific type of defective jacket.

The program initiated by Fuels Development for determining the time-temperature characteristics of the beta-to-alpha transformation in uranium is about one-third completed.

Samples Processed During the Month.

Total Samples Processed: 364

Photographs:

Micrographs	129
Macrographs	200
Total	329

L. P. Bupp

Acting Manager, Reactor and Fuels
Research and Development Operation

LP Bupp:kb

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JW Riches	3/1	Allegheny-Ludlum Steel Corp., Watervaliet, N.Y.	Consultation on the fabrication of zirconium	RW Stewart	No
	3/2	Tube Reducing Corp., Wallington, N.J.	" " " " "	Mr. Brown	"
FW Woodfield	3/1	Superior Tube Co., Norristown, Pa.	Liaison regrading zirconium tube fabrication	HW Cooper	No
	3/2	Tube Reducing Corp., Wallington, N.J.	" " "	Mr. Brown	"
LD Turner	3/12-14	Fifth Hot Laboratory Conference, Philadelphia, Pa.	Co-Chairman technical session at Fifth Hot Laboratory Conference.	--	No
WS Kelly	3/11-12	ORNL, Oak Ridge, Tenn.	Observe techniques for testing radioactive materials	SE Dismuke	Yes
	3/18-19	KAPL, Schenectady	" " "	DD LaRocque	Yes
	3/13-14	Fifth Hot Laboratory Conference, Philadelphia, Pa.	Present technical paper	--	No
DL Zimmerman	3/13-14	"	" " "	--	No
	3/11-12	WAPD, Pittsburgh	Observe techniques for testing radioactive materials	RC Westphal	Yes
	3/18-19	KAPL, Schenectady		DD LaRocque	"
DE Johnson	3/12	Superior Tube Co., Norristown, Pa.	Consultation on zirconium & aluminum fabrication	HW Cooper	No
	3/13	Alcoa, New Kensington, Pa.	" "	DD McCracken	"
	3/14	Damascus Tube Co., Greenville, Pa.	" "	BB Burd	"
	3/15-16	Tube Reducing Corp., Wallington, N.J.	" "	RE Rohrabaugh	"
DR Green	3/1-8	ORNL, Oak Ridge	Special document review project sponsored by AEC.	HF Carroll	Yes

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
RS Kemper	3/6	WAPD, Pittsburgh, Pa.	Discuss radiation effects in structural materials	RH Fillnow	Yes
	3/7	GEL, Schenectady	" "	LF Kendall	No
	3/8	KAPL, Schenectady	" "	CA Bruch	Yes
	3/9	GE Research Lab.	" "	DW Lillie	No
	3/11-12	Nuclear Science & Engr. Congress, Philadelphia, Pa.	Present Paper	--	No
	3/14	BMI, Columbus, O.	Discuss testing of structural materials	F Shober	Yes
GT Geering JE Minor	3/11-12	Nuclear Metals, Cambridge, Mass.	Discuss reactor fuels & metallurgy	H Sawyer	Yes
	3/13-14	KAPL, Schenectady	" "	WM Cashin & CE Weber	Yes
WE Roake	3/14-15	Phillips Pet. Co., Arco, Idaho	Observe & assist in experiment at MTR	R Neidner, GE A Richardson	Yes
KR Merckx	3/11-13	GE, Philadelphia	Discuss solar furnace design equipment	JW Metzger & J Farber	Yes
	3/15	Project Matterhorn, Princeton, N.J.	Discuss high temperature technology	JG Wells	Yes
	3/18-20	KAPL, Schenectady	Discuss strain cycling & shell problems	Dr. Horvay & E Baldwin	Yes
LG Merker	3/11-14	Monarch Mach.& Tool Sidney, O.	Design meeting	CA Bickel	No
HR Gardner	3/11-15	Nuclear Science & Engr. Congress, Philadelphia	Present paper	--	No
TC Nelson	3/25-29	Western Exposition & Metals Congress, Los Angeles, Calif.	Attend Congress & discuss equipment problems	--	No
JH Rector	3/27-29	Dow Chemical Co., Rocky Flats, Colo.	Witness inspection	EJ Walko	Yes
JR Triplett	3/5-8	Atomics International Canoga Park, Calif.	Attend control rod meeting	MC Walske	Yes

SECRET

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HW-49419

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JO Ludlow	3/11-15	Harvey Aluminum, ALCOA, Paddock Engr. Co., Peerless Pump Johnston Pump, Los Angeles, Calif.	Technical consultations on pumps, heat exchangers, piping, ion exchangers, and tanks	GR Smith A Bunke N Ray L Haight --	No
DJ Foley	3/21-22	Argonne Natl. Lab. Chicago, Ill.	Technical consultations on thermal hydraulic questions	FA Lottes	Yes
LH McEwen	3/11-14	Nuclear Engr. Congress Philadelphis, Pa.	Attend Congress	--	No
	3/15	duPont, AE Div., Wilmington, Del.	Technical consultation on experimental techniques concerning transient thermal hydraulics hazards simulations tests	L Bernath	Yes
	3/18	Columbia U., New York, N.Y.	" " "	RP Stein	"
	3/19	Andale Co., Philadelphia, Pa.	" " "	A Wuster	No
	3/20	Alcoa, Pittsburgh	" " "	RH Brown	No
	3/21	ANL, Chicago	" " "	PA Lottes	Yes
RJ Lobsinger	3/11	ANL, Chicago	Inspect loop facilities	NR Grant	Yes
	3/12-14	Natl. Assoc. of Corrosion Engineers, St. Louis, Mo.	Present paper	RU Blaser	No
	3/15	Monsanto Chemical Co., St. Louis, Mo.	Discuss organic coolant technology	M McEwen	No
PA Scott	3/11	Johnston Pumps, Pasadena, Calif.	Discuss types of equipment for the PRPR	P Brown	No
	3/12	Byron Jackson Pumps, Los Angeles, Calif.	" " " "	JR Vidmar	No
	3/13	Peerless Pumps, Los Angeles, Calif.	" " " "	N Ray	No
	3/14	Harvey Aluminum Torrance, Calif.	" " " "	GR Smith	No
	3/14	Alco Products Los Angeles, Calif.	" " " "	JA Langford	No
	3/15	Paddock Engr. Co. Van Nuys, Calif.	" " " "	Mr. Oster & Mr. Lightfoot	No
DR deHalas	3/28-29	N. American Aviation (OMRE) Arco, Idaho Phillips Pet. (MTR), Arco, Idaho	Inspect organic loop at the MTR and discuss organic coolants with N. American at OMRE	W Bley & CA Trilling RE Fearnow	Yes Yes

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
DR Doman	3/11-14	International Atomic Exposition, Philadelphia, Pa.	Discuss gas coolant technology and inspect equipment for use in organic, gas, and liquid reactor coolant studies.	--	No
	3/15	Ford Instrument Co., Long Island, N.Y.	" " "	M Silberberg	Yes
	3/18	GE Rocket Lab., Schenectady	" " "	F Rank, Jr.	Yes
	3/19	BMI, Columbus, O.	" " "	DM Keller	Yes
JM Skarpelos	3/25	Graver Water Conditioning Co. & National Aluminate Co., Chicago, Ill.	Discuss ion exchange equipment and processes	L Limon JM Seamon	No No
	3/26	Illinois Water Treatment Co., Rockford, Ill.	" " "	J Wantz	No
	3/27	WAPD (Bettis Plant) Pittsburgh, Pa.	Discuss pressurized water technology	KH Vogel WT Lindsay, Jr.	Yes
	3/28	Rohm & Haas, Philadelphia, Pa.	Discuss ion exchange equipment and processes	HE Weaver	No
	3/29	Permuit, New York, N.Y.	" " "	H Boehner	No

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
WL McCulla	3/7-8	Superior Steel Co., Pittsburgh, Pa.	Discuss Zr fabrication	FW Woodfield	Yes	300, 303
JE Sabel	3/12	Bausch & Lomb, Seattle, Wn.	Discuss the Balphot metallograph	LA Hartcorn	Yes	300, 303
M McNelly	3/20	Canadian GE, Peterbourgh, Can.	Discuss PRPR Program	JW Riches FW Woodfield	Yes	300, 303
	3/21	"	" " "	LP Bupp JM Atwood RH Purcell	Yes	300, 303 100-D, XXX 100-K, 105-KE

Name	Dates of Visit	Company Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
JK Jackson JL Bunts	3/28	Babcock & Wilcox Lynchburg, Va.	Discuss irradiation damage to graphite	WA Snyder RE Nightingale	No	300, XXX
WE Shelberg	3/11	US Naval Radiological Defense Lab., San Francisco, Calif.	Discuss work on irradiation effects on plastics & elastomers.	R Harrington	No	300, XXX
D Russel	3/11-12	Sutton Eng. Co., Pittsburgh, Pa.	Discuss fuel element fabricating equipment	DC Kaulitz	No	300, XXX
W Larson	3/11-12	"	" "	DC Kaulitz	Yes	300, 306
P Berner	3/11-12	Star Machinery Co.,	" "	DC Kaulitz	No	300, XXX
F Shrade	3/1	UCRL, Livermore, Calif.	Discuss Hanford assistance to UCRL	OJ Wick ID Thomas	Yes	200-W, 231, 234-5
J Duncan F Bosche	3/13-14	"	" "	"	"	"
C Godfrey R Waldron	3/19	"	" "	"	"	"
JE Zerbe	3/6	WAPD, Pittsburgh, Pa.	Discuss pressurized water experimentation	LH McEwen	Yes	300, XXX 100-D, XXX 100-K, 105-KE
G Westfall	3/25-26	KAPL, Schenectady	Discuss thermal cycle testing	LP Bupp LH McEwen	Yes	300, XXX 100-D, XXX 100-K, 105-KE

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

MARCH 1957

FISSIONABLE MATERIALS - 2000 PROGRAM

METALLURGY

Fuel Preparations Department Specification Review

Modifications in FPD specifications covering the manufacture of enriched fuel elements have been reviewed for conformity with nuclear safety standards.

Buckling Measurements of Enriched Uranium - Water Lattices

A series of buckling measurements have been initiated using enriched bare fuel elements of 1.466% by weight U-235. These fuel elements are 1.394" O.D., 0.464" I.D., and 8" long. The experiment is intended to show the feasibility of making buckling measurements at a later date with similar fuel elements of 1.6% enrichment. At the higher enrichment, the size of the loading commensurate with safe procedures in the exponential laboratory will be somewhat reduced. In order to provide more information than has been obtained to date on the effect of varying the size of the loading over a wide range, measurements will be taken with the 1.466% fuel elements with loadings of 31, 43, and 55 tubes at each of the lattice spacings 2.0", 2.2", and 2.6". The following measurements have been completed:

No. of Tubes	Distance Between Rods (inches)	H_2O/U (by volume)	Reflector Savings*	Buckling (10^{-6} cm^{-2})
43	2.2	1.92	7.14 cm.	6307
55	2.2	1.92	7.14 cm.	6438

* Estimated from Brookhaven data.

Further data are required to determine if the difference of 131 μB is the result of a dependency of the reflector savings on the effective size of the cylinder.

With the 1.6% enriched uranium it will be necessary to conduct the experiments with 43 or fewer rods; as the effective size of the cylinder is reduced, the reflector savings become of relatively greater importance to the determination of the material buckling. The reflector savings is expected to be the same for both the 1.466 and 1.6% uranium.

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION PILES

Buckling Measurements on Internally and Externally Cooled Slugs

Buckling measurements have been completed in a C-Pile-type lattice with I and E (1.37" O.D., 0.48" I.D.) fuel elements, and with solid, 1.34" O.D. elements. These measurements were taken to provide further data on the reactivity gain which is expected with water loss for I and E fuel elements in C-Pile. The quantity of prime interest is the difference between the dry-wet buckling values for the I and E fuel elements as compared to the solid elements since large numbers of the I and E elements are being loaded in C-Pile. The measurements were taken in a small exponential pile ($\sim$4' x 5' x 7'); C-Pile process tubing was used. The measured buckling differences are listed as follows:

Dry-Wet Buckling Differences in 8-3/8" Lattice

Fuel Element	Dry Buckling - Wet Buckling	Amount of Water in Wet Case
I and E	53.2 μB $\pm$ 2 μB	3.11 cc/cm
Solid	47.1 μB $\pm$ 1.8 μB	2.85 cc/cm
Difference	6.1 μB $\pm$ 2.7 μB	

The uncertainty quoted for the solid slug difference is the standard error based upon the "goodness of fits" obtained for the measurement of relaxation lengths. However, in calculating the value of the error, it was assumed that the different methods of analysis treated independent data. This assumption was not strictly true. The error quoted for the I and E slugs is an intuitive value based on the following considerations: (1) the fits obtained exhibited greater deviations and yielded a standard error greater than 2 μB; (2) the precision of the difference, as indicated by repetition of some of the experiments and by alternate methods of analysis, appeared to be about 1 μB; (3) therefore, a compromise was made of 2 μB, which is felt to be still conservative.

In order to convert the results of the exponential experiments to reactivity changes in the production pile, use was made of the value of 964 inhours determined at start-up for the inhour difference between the wet and dry pile with solid slugs. This yields a calibration factor

$$\frac{964}{47.1} = 20.5 \frac{\text{inhours difference for 105-C}}{\mu\text{B difference for exponential pile}} .$$

The above factor automatically corrects for inconsistent changes in migration areas (wet and dry) caused by the voids in the production piles. Assuming the factor is applicable for small changes in the quantity and distribution of the water, a value of (20.5) (6.1 $\pm$ 2.7) = 125 $\pm$ 55 inhours is calculated

for the additional gain in reactivity when the pile loaded with I and E slugs loses water, compared to the gain in the case when the pile loaded with solid slugs loses water.

When the above value of the additional gain is combined with the value determined with the PCTR, namely, 150 ± 150 inhours by weighting them according to the designated uncertainties, the value obtained is 128 ± 55 inhours.

The bucklings of a series of lattice spacings will be measured using natural uranium slugs, 1.37" O.D. and 0.48" I.D. canned I and E. The canned size is 1.475" O.D. by 0.37" I.D. The 7-11/16" lattice has been loaded with dry, uranium-filled process tubes and will be measured first. Since measurements have already been completed with similar slugs of 1.44% enrichment, information will be obtained on the effect of enrichment on the "crossover point" (lattice spacing for which dry and wet bucklings are of equal value).

Buckling Measurements for Enriched Uranium, Graphite Lattices

The series of buckling measurements in the small ($\sim$4' x 4' x 6') graphite, exponential piles, with 1.44% enriched uranium, was completed with the measurement of the dry 7-11/16" lattice. A value of 609 μB was measured. The fuel elements were 1.37" O.D. by 0.48" I.D. and were canned I and E. The wet-dry buckling crossover point occurred at 8.35".

Variation of Graphite Diffusion Length with Temperature

A diffusion length measurement was made in the graphite stack, at 100° C, as the stack was cooling. A value of 55.3 cm was measured which compares well with the value of 55.6 cm which was measured when the pile was being heated. The pile has now cooled to about 30° C and is losing heat very slowly.

STUDIES RELATED TO FUTURE PRODUCTION PILES

General Reactor Theory

A manuscript was prepared covering a talk presented at the AEC Control Rod Meeting, March 6-8. This manuscript will appear in the proceedings of the meeting to be issued by TIS, Oak Ridge.

A theorem was proved that a reactor will burn fuel in such a fashion as to increase the required critical mass and thus shut itself off.

Correlation of Theory with Experimental Buckling Measurements

The IBM-702 code written to reduce exponential experiment counting rates to bucklings is now in the de-bug stage.

Resonance Escape Studies

It is possible to fit experimental U-238 resonance integrals with a curve having the form $A + B\sqrt{\frac{S}{M}}$. Calculations performed during the past month show that theoretical results for individual resonances can also be fitted to this form.

Crystal Spectrometer

A chamber, designed to provide liquid nitrogen cooling for a polycrystalline beryllium filter for slow neutron measurements, was obtained from the Technical Shops. This chamber has developed leaks apparently from thermal stresses. Further development work will be necessary.

The rectangular slit systems to provide requisite beam collimation for fission measurements in the 1 to 10 ev energy region are being aligned and tested. The tests have not proceeded far enough to determine if the previously calculated beam intensities will be realized.

Millimicrosecond Time Analyzer

A moving film camera has been used to record the single fast scaler output of the timing loops. About 1500 total counts can be registered in a single run of 70 to 100 feet of film. The time coincidence curve of two cascade gamma rays from Co^{60} has been investigated further. The better statistical precision available with the film recording gives a measured width of about 1.7 millimicroseconds which agrees quite well with the width previously determined with poorer statistics. A long term instability of channel width of the timing loops of about 0.005 millimicrosecond has been discovered although the short term stability is about 10^{-4} millimicrosecond.

PCTR Core Oven

The oven to be used for elevated temperatures of test cores in the PCTR has been equipped with a new cooling coil system. Much better temperature control of the oven shell can now be maintained. In a test the maximum shell temperature was only 25° C above that of the inlet cooling water even when the vacuum insulation was changed to a helium atmosphere for heat removal from the graphite core at a temperature of 400° C. The oven has been placed in storage until time is available for the PCTR experiments.

Theory of PCTR Experiments

It is necessary to modify the line source Fermi age kernel to account for a cylindrical cavity in the small source analysis of the PCTR. Progress on this mathematical endeavor has been made during the past month.

Progress has been made on the spatially dependent neutron thermalization calculation. This problem concerns itself with the neutron spectrum in the vicinity of a plane temperature discontinuity appearing in pure moderator. On the basis of the heavy gas model a partial differential equation describes the neutron distribution. This equation is separable into spatial and spectral equations. The spatial equation is solved in terms of trigonometric and hyperbolic functions. The spectral solution multiplies a maxwellian by confluent hypergeometric functions. Work is now underway on fitting the boundary conditions.

IPR Results

From analysis of PCTR data in connection with the IPR experiments, the following k_{∞} values are now given for a large cored fuel element, and a cluster rod

assembly. The cored element had an O. D. of 1.68" and an I.D. of 0.75". The cluster assembly consisted of seven 0.5" diameter rods evenly distributed in the process tube. Both types of fuel elements were positioned in an aluminum process tube which was 2" in I.D.; the lattice spacing was 7.5".

Measured k_∞ Values in PCTR

Coolant	k_∞
Seven Rod Cluster	
Air	1.0284 ± 0.0017
Water	1.0127 ± 0.0056
Cored Element	
Air	$1.0216 \pm \begin{matrix} 0.010 \\ 0.001 \end{matrix}$
Water	1.0293 ± 0.0027
MIPB	1.0335 ± 0.0060

Further analysis of previous PCTR measurements is continuing and a summary of the results applicable to the IPR program is being completed.

Miscellaneous PCTR Experiments

(a) Dependence of Measured Cadmium Ratios on Detector Thickness

For the purpose of investigating the dependency of cadmium ratios and resonance integrals on detector thickness various thicknesses of half-inch diameter Au and Cu foils were activated in the PCTR. The bulk of these irradiations was done in a core configuration in which four, PCTR U-235, driver elements were positioned on the corners of a 15-inch square centered on the core axis. This fuel configuration yielded a 1/v cadmium ratio of approximately 70 at the center of the core.

(b) Dependence of Neutron Spectrum on Core Configuration

Additional irradiations were performed in core fuel configurations which yielded 1/v cadmium ratios of 25, 40, 125. In these irradiations, the respective thicknesses of the Au and Cu foils were held constant for the purpose of investigating the dependency of the neutron energy spectrum on the various core fuel configurations.

(c) Sodium Floride Detectors

Sodium floride and U^{235} Al alloy materials were activated for the purpose of making comparisons with a thin 1/v BF_3 detector.

Analysis of the experimental data obtained in these experiments is incomplete.

Thermal Test Reactor

Experiments to measure the TTR temperature coefficient are being conducted. To make these measurements, the effects on the reactivity caused by varying the water level in the annulus and the fuel tubes was measured. The temperature coefficients are being measured at these various water levels.

An increase in reactivity was obtained by adjusting the water levels to an optimum level. This made it possible to remove additional fuel disks.

SEPARATIONS

Criticality Experiment for Enriched $UO_3.H_2O$ Mixtures

The second part of the initial phase of the criticality experiment (measurement of k_∞ for enriched $UO_3.H_2O$ mixtures) was completed in the PCTR. The uranium enrichments were 1.00% and 1.15%. Measurements were taken for H/U ratios of about 4, 6, and 8. The results imply that k_∞ would be unity for an enrichment of 1.06% at the H/U ratio of six. Further, the data indicate that the highest k_∞ will be obtained for H/U ratios in the range of 9 to 10; thus, information is needed in this range.

Because it was necessary to use the PCTR on another experiment, an effort was made to measure k_∞ in the TTR using the 1.00% enrichment at an H/U ratio of six. This attempt was not successful since the reactor could not reach criticality with the internal thermal column replaced with the $UO_3.H_2O$ mixture in an aluminum tank; apparently there was insufficient moderation with this core configuration for the reactor to become critical with the present fuel load.

Calculation of Fast Critical Masses

Additional refinements have been made in the modal probability method of calculating fast critical masses. In particular, a U-238 fission cross section of 20 mb is used for the second energy group (0.4 - 1.4 MEV). A paper on the modal probability method has been prepared for presentation at the Nuclear Safety Group's Meeting at Los Alamos, April 11-12.

Pu Critical Mass Laboratory

A survey for possible location of a minimum critical mass facility was made. Locations reviewed included the 221-T Plant, the former P-11 Site, the 300 Area, and the Hot-Semi Works in the 200-E Area. Preliminary considerations indicate that it may be most feasible to locate this facility adjacent to the Hot-Semi Works where advantages could be taken of the many plutonium-handling facilities existing there. It is planned that the plutonium-handling equipment, including the critical assemblies, would be housed in a steel sphere which would provide adequate containment. A large house trailer located at a required distance from this sphere would house the control center. In order to establish the feasibility of this proposal, a set of criteria has been prepared to permit preparation of a scope and a cost of the sphere.

Plutonium Mass Spectrometer Consultation

Further consultation has been provided to the Chemical Instrumentation's plutonium mass spectrometer project.

Neutron Age Measurements

The shipping cask for the irradiated Na-Be sources has been received from Technical Shops along with the component caps and source mounts. The preparation of satisfactory indium foils was investigated. Rolled foils were determined to have variations from uniformity of the order of twenty percent which is unsatisfactory. Attempts to electroplate suitable indium foils were unsuccessful. Thin electroplated indium foils are commercially available and will be tried.

INSTRUMENTATION AND CONTROL

Systems Research

All computer circuits necessary to construct a reactor simulator suitable for coolant loss study have been developed and placed on the computer. Various test runs have been completed on the individual circuits. These circuits are:

a. Reactor kinetics
b. Metal heat transfer
c. Moderator heat transfer
d. Xenon generation
e. Control rod
f. Power level and coolant loss scram
g. Coolant loss function

Final tests are now being made on the operation of the circuits connected to form the complete simulator. Preliminary runs should be made within the week.

Computer maintenance is now reduced to that normally found in Analog installations. Goodyear Aircraft is still providing technical assistance and will do so until complete satisfaction is obtained. Many replacement parts as well as original components for the computer are on back order with Goodyear and will not be received until June of this year.

Components Research and Development

Development continued on an experimental detecting system for determining the low energy limitations of scintillation X-ray and gamma detection. The characteristics of several multiplier phototubes were studied for use in the detector. It was determined that a relatively new tube, the 14-dyanode RCA 6810, is the most desirable.

An experimental sun tracking control system was developed and demonstrated as a possible means of keeping the solar furnace pointed at the sun. The device was designed to keep the solar mirror angle correct to ± 1-1/2 minutes of arc. This permits no more than 0.01" of drift in the focus of the solar furnace.

WEAPONS - 3000 PROGRAM

Magnetic Balance

Testing of the electronic system of the magnetic suspension balance has continued. A 10-mg weight has been supported but electronic noise has limited the precision to about one part in 10^4 so far.

REACTOR DEVELOPMENT - 4000 PROGRAM

STUDIES RELATED TO THE PLUTONIUM RECYCLE PROGRAM

PCTR Lattice Measurements

The calandria for measurements of a 7-inch lattice in the PCTR core was completed, treated to prohibit D_2O corrosion, and installed in the PCTR. The 2,000 pounds of D_2O arrived and was added to the calandria plumbing system. The 0.5-inch diameter UO_2 fuel rods for the cluster fuel elements were received from Reactor Fuels Research and Development Operation. The PCTR was brought to critical without fuel in the D_2O moderated test cell. Measurements have been made of the control rod strengths and of the reactivity values of driver fuel rods and UO_2 cluster fuel elements and test lattice components. Measurements of the value of safety disk strengths and of the effect of photoneutrons on flux period measurements have begun.

BIOLOGY AND MEDICINE - 6000 PROGRAM

BIOPHYSICS RESEARCH

Atmospheric Physics

An extensive experimental and theoretical study of the diffusion and transport of stack effluents in stable atmospheres was completed. This study demonstrated that there is considerable variability in the diffusive capacity of stable atmospheres and that a large portion of this variability can be predicted from suitable meteorological measurements. The classical diffusion models were shown to be only partially correct; in particular, Sutton's model for the horizontal diffusion was substantiated but failed completely in the vertical dimension. It was also demonstrated that the horizontal distribution of the effluent material is largely predictable from a knowledge of the large-scale variations in wind direction and the mean wind speed, a feature which permits the use of standard wind instruments which are too sluggish to respond to the small-scale velocity fluctuations which are responsible for the actual diffusive mixing of the effluent material. The vertical distribution of the material appeared to be controlled primarily by the Richardson Number, a stability parameter involving the vertical temperature and wind speed profiles.

A network of 1056 steel stakes was placed in a polar grid around the Meteorology Tower in order to locate sampling points for ground level measurements of concentration of tracer materials emitted from various elevations on the Tower. Sampling points were spaced at five degree intervals of azimuth from North clockwise through Southwest and at 100-foot radial intervals from 400 to 2500 feet. When used in conjunction with our recently completed fluorescent pigment

tracer system, this experimental set-up will provide the measurements necessary to determine the long- and short-period average concentrations or dosages within a half-mile of an elevated source.

The Analytical Laboratories Operation was approached with a request for a particulate tracer material which can be used in the measurements of wind erosion of particulates. The primary requirements were specified to include (1) a non-indigenous material which may be detected in very small concentrations, (2) density in the vicinity of 2.5 to 3.0 gms/cm^3, and (3) controllable particle size. Powdered aluminum has been proposed as a suitable material and is under study.

Consultation services were provided on the problem of potential hazards from the proposed Plutonium Recycle facility. Preliminary estimates of the stack facilities needed to obviate hazards from various types of releases were provided but the problem was still under active consideration at month's end.

Operation of the wind station network continued satisfactorily and the data from this network were reduced on a routine basis.

DOSIMETRY

An improved coincidence scintillation counter for plutonium detection was completed. Good optical coupling of the two photomultipliers to a thin NaI crystal permitted operating at sufficiently low gain that the coincidence circuits could eliminate practically all the pulses resulting from thermal noise in the tubes. The counter detects plutonium X-rays with nearly 100% efficiency. Background counts are still present and must be eliminated. Apparently some of these result from light produced in the lucite light pipe; this may be Cerenkov radiation from cosmic rays.

The Van de Graaff accelerator operated with only routine maintenance during the month.

Background suppressors were fabricated for dealing with the D(d,n) background neutron problem. The suppressors are pairs of slits which can be used to define the Van de Graaff beam so that deuterons do not strike and become imbedded in parts of the system to form unwanted deuterium targets. The suppressor slits themselves will be heated to red heat to drive off any deuterium in them. These suppressors will not eliminate deuterium contamination in the analyzing chamber; this problem will be dealt with when designing the new chamber required for the proposed expansion in the facilities in the Van de Graaff.

The effect of room scattered neutrons from an Sb-Be source on measurements with a double-moderator neutron fluxmeter-dosemeter was investigated. As at higher energies, scattering effects are quite large; when correction for them is made, the ratio of the counting rates from the two moderators is independent of distance from the source.

Three copies of the 4-1/2-inch moderator neutron dosemeter have recently been made locally. Slight variations among the copies have resulted in additions to knowledge of the properties of the instrument. One of them contains an

extra 1/16-inch sheet of aluminum in the moderator; it has 14% higher sensitivity for SbBe neutrons but essentially the same sensitivity for higher energies. It was necessary to make another of the copies with a steel case instead of an aluminum one; this moderator gives about one-half the sensitivity of the original probably because of extra slow neutron absorption in the steel.

Increase in temperature of the pressure extrapolation system used for X-ray studies produced no change in the current from a graphite-walled chamber. Library research indicated that it may not be possible to heat the system high enough to drive off all the nitrogen, which presumably is the cause of the observed disagreement with theory. Instead, a chamber made of some other low atomic number material that would not be expected to adsorb gas will be tried.

A current integrator was completed for use in experiments with the electron Van de Graaff. It has integrated charge ranges of 2.5, 25, 250, and 2500 microcoulombs. Leakage current appears to be less than 10^{-12} amp. Wiring for remote calorimetric measurements and remote bath control at the electron Van de Graaff was completed.

A theoretical study was made of the exposure dose and absorbed dose rates to be expected at the surface of an emitting material of high atomic number. The high atomic number means that scattering of photons in the medium can be neglected compared to absorption processes but also that fluorescence radiation must be taken into account. The absorbed doses were calculated with the help of the age theory developed earlier. The results of this study were applied to analysis of experimental results for the dose rate from plutonium metal. The measured X-ray dose rate is lower than that expected theoretically. This may be due to the measurement having been made with a graphite wall ion chamber and is part of the reason for the current concern with such chambers. The measured gamma ray dose is higher than that expected and there is no clear reason for this.

INSTRUMENTATION

Tests on the Water Velocity Indicator for use in plant wells by the Geochemical and Geophysical Research Operation were completed satisfactorily and the instrument was delivered for field use. The instrument is expected to detect the direction and speed of underground water flow when the probe is placed in the well water.

All necessary specifications and drawings for the Radiotelemetering System have been forwarded to the Construction Engineering Operation for use in bid proposals. Prototype integrating circuitry for the remote data stations was completed.

An experimental dual-filter alpha air monitor for the continuous monitoring of airborne Pu alpha particles was completed and is being tested in the laboratory. The estimated sensitivity of the instrument is such that it will detect and alarm on 200 M.P.C. of airborne Pu alpha contaminant in three minutes. This is a factor of 50 more sensitive than the original single filter model.

The final design, with thoroughly tested circuitry, for the Solar Radiation

Integrator (Pyrheliometer) was completed and sent to the Atmospheric Physics Operation.

One channel of three necessary channels of the Pulse Matrix portion of Radioisotope Analyzer was completed and is being tested.

Experimental work on the Scintillation Transistorized Alpha Hand and Shoe Counter was continued. A probe consisting of a new type of phototube (RCA 6372) and a 4-1/2 x 8-inch lucite light pipe was designed. Geometry variations are less than 5.0% across the area of the sensitive surface. One experimental channel for the counter was fabricated using the probe, a transistorized amplifier, and a transistorized register drive circuit and tested. The minimum detectable amount of Pu alpha is less than 100 d/m at any place on the probe face. This is a factor of five more sensitive than the presently-used alpha hand counters of the air chamber type.

A printed circuit for the register drive circuit was designed.

A relationship between particle size and voltage pulse height output was established for the Dust Meter. The Dust Meter is an instrument which utilizes the charge on dust particles pulled through a critical orifice. The charge is deposited on a wire across the orifice and the resultant voltage pulses are amplified and counted. The larger the particle, the greater in magnitude of the resultant voltage pulse.

Work on scintillation scanning techniques was continued. It was found that results obtained by scanning various radioisotope sources could be recorded on photographic paper with the use of a pulse-controlled stroboflash tube. Ratios of counting rates of 10:1 or more can be discerned from viewing the paper.

The electrical and mechanical specifications for the Dog Counter for Biology were completed and the necessary purchase orders and data were sent to Biology.

Experimental work was continued on a scintillation, partially-transistorized, portable fast neutron dose rate meter. The circuitry was completed, and four-inch diameter aluminum sphere was fabricated. The inside of the sphere is coated with 10 mg/cm^2 of polyethelene which is, in turn, coated with ZnS phosphor. The resultant n,p reaction results in light photons from the ZnS, and the light is viewed with a phototube. Testing of the instrument with a Po-Be fast neutron source produced about 400 c/m per mrad/hr from the source with the instrument biased to read zero in a 200 mr/hr field from a Co^{60} source.

Further testing will determine dose-rate capabilities of the instrument for counting rate versus fast neutron energies. With the Po-Be source, a dose-rate of 0.1 to 0.2 mrad/hr can easily be ascertained.

Evaluation tests were completed on metal wall halogen-quenched GM tubes. The tubes proved to be better than similar organic-quenched tubes. Evaluation tests were started on a vibrator high voltage supply and on hearing-aid type headphones. Instrument performance specifications were reviewed and rewritten, and acceptance specifications were completed for the Samson-type survey meter.

The modification and calibration of the Hasting's detector for the Wind Component

Meter was completed. With the addition of suitable amplifiers and recorders, useful information can be obtained. Additional work on a recording system is contemplated for the next fiscal year.

CUSTOMER WORK

Weather Forecasting

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	79.6
24-Hour General	62	83.8
Special	60	85.0

Summary of the Weather

The precipitation total of 1.86 inches was five times the monthly normal and was the greatest for March in 45 years of record for the Hanford Area. The previous high for the month was 1.15 inches in 1938. The temperature average for the past March (44.0) was 1.7° below normal. There were strong winds on the 10th. The wind speeds for the month as a whole, however, averaged about 2 miles per hour below normal.

Optical Shop

The routine work in the Optical Shop included the fabrication of an elbow telescope, a group of glass bearings, and a mount to adapt a Kodak motion picture camera to a Bausch and Lomb Macro camera stand; the servicing of two crane periscope heads, and the polishing of some calcium fluoride crystals.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H. W. Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
JL Powell	Mar. 11-15	Univ. of Oregon Eugene, Oregon	Consultant	JE Faulkner	Yes	300; 303

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
DA Kottwitz	Mar. 1-15	ORNL, Oak Ridge, Tenn.	Declassification Program.	HF Carroll	Yes
DA Kottwitz	Mar. 18	KAPL Schenectady, N. Y.	Discuss neutron thermalization.	M Nelkin	Yes
GW Stuart	Mar. 5	Vallecitos Atomic Lab. General Electric Co. Pleasanton, Calif.	Discuss Industrial Nuclear Safety Committee.	WJ Ozeroff	No
GW Stuart DD Lanning	Mar. 6-8	Aeronautical Sciences Building Los Angeles, Calif.	Attend Control Rod Meeting.	MC Walske	Yes
N Ketzlach	Mar. 11-14	Nuc. Science and Eng. Congress	Present paper and attend meetings.		No
N Ketzlach	Mar. 15	BNL Upton, L.I., N. Y.	Discuss exponential experiments.	R Sher and G Price	Yes
N Ketzlach	Mar. 18-19	SRL Augusta, Ga.	Discuss nuclear safety problems.	HK Clark	Yes

VISITS TO OTHER INSTALLATIONS (CONT'D)

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
N Ketzlach	Mar. 20-21	Mallinckrodt Chemical Works, St. Louis, Mo.	Discuss nuclear safety problems.	KJ Caplan JU Shepardson	Yes
RA Bennett	Mar. 13	BNL Upton, L.I., N. Y.	Discuss critical and exponential experiments.	K Downes	Yes
RA Bennett	Mar. 14-15	KAPL Schenectady, N. Y.	Discuss neutron favorableness factors.	GB Gavin	Yes
RA Bennett	Mar. 18-19	ORNL Oak Ridge, Tenn.	Discuss cross section and resonance interval measurements.	RL Macklin	Yes

Chemical Research & Development Operation

ORGANIZATION AND PERSONNEL

D. M. Polinsky, Junior Scientist, transferred to Fuels Preparation Department, assigned to Employee Relations Operation.

J. L. Nelson, Chemist I, was hired and assigned to Chemical Effluents Technology.

Arvella D. Peterson, Laboratory Assistant, was transferred in to Analytical Chemistry Operation from Exposure Records and Evaluation.

Dorothy T. Harless and Ethel Z. Poirer, Laboratory Assistants in Analytical Laboratories Operation terminated.

Roberta T. Webster, Technologist "C", in Analytical Laboratories Operation terminated.

TECHNICAL ACTIVITIES

2000 PROGRAM - PRODUCTION OF FISSIONABLE MATERIAL

IRRADIATION PROCESSES

The KAPL-120 loop program is complete, analytical services involving two people have been shifted to support 1706-KER studies.

Confirmation of gamma spectrometry is continuing for routine measurement of isotopes in reactor effluent water. Instrument calibrations at 1706-KE are complete for Na-24, Mn-56, Zn-65, and Sc-46 possibly (high Mn-54 and Zr-Nb-95 may distort Sc-46). Comparisons showed standard chemical separation methods gave 20 per cent high results for Mn-56 and 16 per cent low results for Na-24. By the middle of April exclusive use of gamma spectrometry is anticipated for most isotopes that Analytical Chemistry recommended for spectrometric measurement.

REACTOR EFFLUENT STUDIES

Automatic Analyzing Monitor

Contaminants in the P^{32}-containing stream of the monitor continued to present difficulties. Chemical methods designed to remove As^{76}, I^{133}, and W^{187} were tried in the flowing system. The use of nitric acid to replace hydrochloric acid in the $Na_2S_2O_3$ reduction step for As^{76} resulted in perceptible improvement in I^{133} removal. A tungstic acid bed treated with cinchonine retained a large fraction of the W^{187} isotope present. Because of the relatively small concentration of P^{32} in the reactor effluent stream, however, a significant fraction of the shorter-lived isotopes (approximately 1 day half-life) was still present at 24 hours. Fifteen to twenty per cent of the counting rate at 24 hours originated from the contaminants present.

The use of nitric acid to replace hydrochloric acid was beneficial in two other respects but a disadvantage in a fourth. Sample residue in the aluminum cup is firmly held and not light and feathery as it is when hydrochloric acid is used. Materials for valves and other components are not as difficult to specify for

corrosion resistance when nitric acid is used to replace hydrochloric. The disadvantage is that nitric acid causes gas evolution when it contacts the CuS bed used for As^{76} removal. The resulting gas generation heaves the CuS column to a serious degree.

Experiments for determining Dowex-50 column life showed that much smaller columns than those previously anticipated could be used and still give long service without regeneration or replacement. A throughput of 1.4 liters of reactor effluent per cc of resin could be achieved before significant breakthrough occurs.

Process Assistance

Sampling specifications previously established for purging-while-operating were waived to encourage the development and application of short duration purges. Purges using 25 ppm diatomaceous earth and lasting for one minute appeared to be effective in film removal at 105-C and have the advantage of releasing smaller amounts of radioactive contaminants to the Columbia River. The need is not so great for sampling during purges under these conditions. Samples obtained during short purges, too, are likely to be unrepresentative of the average purge material sent to the river, hence would not be particularly valuable in assessing the radioactive debris discharged.

Arrangements were confirmed which will permit sampling of reactor effluent from tubes loaded with aluminum-nickel alloy clad fuel elements (M-388) during a forthcoming production test to evaluate the effectiveness of this alloy in resisting corrosion. Reactor effluent will be analyzed to identify isotopes of concern from a Columbia River contamination standpoint.

Laboratory equilibrium tests were performed with sludge and water from the 107-D basin to determine the ability of Turco 4306-B, a decontaminating agent, to desorb Cs^{137} and Sr^{89-90} from the sludge. The results indicated that the concentration of Sr^{89-90} was 10 times greater and Cs^{137} 6 times greater in 107 Basin water containing Turco 4306-B after contact with the sludge. The proposed use of this agent to decontaminate reactor tubes poses the possibility of desorbing long-lived radioisotopes from the accumulated sludge in the 107 retention basins. Following a conference with interested personnel, experiments were planned to investigate the effect of variables such as pH and Turco concentration on the desorption of long-lived radioisotopes from the sludge.

The second attempt to correlate operating data with reactor cooling water effluent analytical results failed to develop the hoped for correlations. A higher degree of correlation would have provided a basis for predicting river pollution rates under future reactor operating conditions. Of particular interest was the strong effect of each of the changes in process water treatment on the concentration of the majority of isotopes compared to the relatively weak effects from changes in other operating variables.

Canal-Lake System Evaluation

Field investigations to develop information concerning the hydrology of the region between Gable Mountain and the river are scheduled as wells become available for study. Six additional wells in the area are included in the well-drilling contract recently awarded. A well in the northwest corner of 100-F Area was recently completed for supplying water to research installations. A pumping test was performed

on this well, using a portable, electric, submersible pump. The main aquifer in the region was found to be a 15-foot thick gravel stratum near the top of the water-bearing formation. A transmissibility of 59,000 gal/day/foot for the region and an average permeability in the gravel bed of about 3,900 gal/day/sq.ft. is indicated. Further aquifer evaluation tests will be conducted as wells become available to develop an integrated pattern of aquifer characteristics in the region.

METALLURGY

To support PCTR calibration five Doe Bare C-type slugs are being analyzed for uranium, U-235, and impurities. Analysis of uranium is 50 per cent complete. High precision and accuracy are absolutely essential. The slugs were wafered and dissolved in concentrated hydrochloric acid. Uranium is being titrated with ceric sulfate according to an Operations Research & Synthesis recommended pattern including interspersed titrations of a simulated dissolution of known uranium concentration.

In support of a Process Engineering (FPD) study to reduce slug ruptures, the gases in 13 voids between unirradiated slugs and cans were characterized by means of the ion resonance mass spectrometer.

SEPARATIONS PROCESSES

REDOX

Chemical Stability of 2-n-Butyltetrahydrofuran

Solvent properties for 2-n-butyltetrahydrofuran were reported last month. Recently completed chemical stability tests on this material indicate about the same stability toward nitric acid as is shown by hexone, i.e., the same dependence on nitric acid concentration, on nitrous acid concentration, and on temperature. "BTF" thus appears equivalent to hexone in chemical stability and somewhat superior to hexone in solvent power for uranium and selectivity for uranium versus zirconium.

PUREX

HA Column Studies

Development work on a satisfactory cartridge for organic phase continuous operation in the Purex Plant HA Column has resulted in the following specifications:

Extraction Section. Cartridge to consist of stainless steel nozzle plates having 3/16-inch-diameter holes, 23 per cent free area, and 0.040-inch-deep nozzles on two-inch plate-to-plate spacing. Louver plates having 23 per cent free area are to be located 14, 40, 80, and 120 inches below the top nozzle plate.

Scrub Section. Cartridge to consist of alternate groups of four stainless steel sieve plates having 0.080-inch-diameter holes and 23 per cent free area and two Ziegler process polyethylene sieve plates having 3/16-inch-diameter holes and 23 per cent free area all on one-inch plate-to-plate spacing. Four louver plates are to be included in the scrub section.

If it is believed necessary to insure at least feed point DF before subjecting the plastic plates to the solutions, a five-foot section of standard cartridge (1/8-inch-

diameter holes, 23 per cent free area and 2-inch spacing) should suffice. However, with the controlled interface at the bottom of the column it is not possible to predict with certainty which phase will be continuous in the standard cartridge section.

NEW PROCESSES

Anion Exchange Process for Plutonium Recovery

Experiments to determine the effect of temperature on the loading of Dowex 1 anion exchange resin with plutonium disclosed a maximum in the pseudo equilibrium capacity occurring between 60 C and 70 C (see accompanying table). The presence of this maximum perhaps arises from a difference in the temperature dependence of the equilibrium constants of the various reactions important to the process. This may mean that feed compositions which are optimum at 25 C may not be optimum at elevated temperatures and an adjustment in feed nitric acid composition may lead to higher capacities.

TABLE II

EFFECT OF TEMPERATURE AND ELUTANT COMPOSITION ON THE LOADING AND ELUTION OF DOWEX 1, X-4 (50-100 MESH) ANION EXCHANGE RESIN

Feed solution: 0.55 g/l Pu, 7.2 M HNO_3. Flow rate 20 ml/min/cm^2.
Elutant flow rate: 0.5 ml/min/cm^2.

Loading Temp. °C	Capacity[a] g Pu/l Resin	Elution Temperature °C	Elutant Concentration HNO_3 M	Product Concentration Pu g/l	expt'l. Pu g/l (Theor.)
25	57	25	0.25	28(non eq.elut.)	63
40	73	40	0.35	55	57
50	93	50	0.25	63	63
60	128	60	0.25	62	63
60	130	60	0.75	37	38
60[b]	125	60	0.35	63	57
70	123	50	0.35	59	57
80	80	80	0.25	64	63

(a) At 50 per cent breakthrough.
(b) Resin previously used in run at 80 C.

The elution behavior is markedly improved with increasing temperature, principally because of an improvement of the kinetics. Whereas, elution at 25 C results in a spread out elution band and a peaked elution curve, elution at 50 C results in a sharp elution band and almost "square" elution curves, indicative of equilibrium conditions during elution. This, of course, means that higher flow rates are possible at elevated temperatures with no loss in product concentration. In those cases where the elution porcess was equilibrium controlled, the product concentrations agreed satisfactorily with values calculated from a previous semi-theoretical study. This same hypothesis was used to predict the effect of increased nitric acid in the elutant. Agreement with experiment was quite satisfactory.

The optimum elutant composition is probably in the range 0.30-0.35 molar nitric acid. The use of 0.35 molar nitric acid has resulted in complete removal of plutonium from the resin in every instance tested; 0.25 molar nitric acid, on the other hand, has been observed to leave a very slight residue when used at elevated temperatures, undoubtedly because of hydrolysis of plutonium(IV) and polymer formation.

The purity of plutonium nitrate recovered by the anion exchange process has been determined by spectrochemical analysis. A three column volume wash (7.2 molar nitric acid) of the loaded column was sufficient to produce plutonium comparable to that purified by multiple peroxide precipitations. For example, in a run using as a feed, diluted Redox AT solution to which had been added 10,000 ppm iron, 1,000 ppm phosphorous (a phosphate) and 2,000 ppm each of chromium, manganese and nickel, the total ionic impurities in the product, based on plutonium were 110 ppm of which 20 ppm were magnesium and 50 ppm were sodium.

Studies to date have demonstrated the chemical feasibility of recovering highly purified plutonium nitrate, in concentration of 60 g Pu/l or greater, from Purex 1BP or 2BP streams by the anion exchange process.

Dissolution of Zircalloy-2

Further study of the dissolution of zircalloy-2 by ammonium fluoride solutions indicates considerable promise for this technique as a means of selectively dissolving zircalloy-2 cladding off uranium metal fuel elements.

A run in which a uranium wafer and a coupon of zircalloy-2 were simultaneously exposed to boiling six molar ammonium fluoride for a period of one hour resulted in dissolution of zirconium to a concentration of about 0.97 molar (at an average rate of about 30 mils/hour) but produced a weight loss of only 0.2 per cent of the uranium. The small amount of uranium in the solution separated out as a green precipitate when the solution was cooled to ambient temperature. The concentration of uranium in the cooled supernatant was only 0.074 grams uranium per liter, corresponding to a loss of 0.00075 per cent of the uranium charged. Similarly, exposure of sintered uranium dioxide to boiling six molar ammonium fluoride for 2.5 hours resulted in only slight attack, with production of a green solution. Again, a green solid separated on cooling, leaving a "water-white" supernatant.

These observations indicate a high probability that zircalloy-2 jackets can be selectively dissolved off uranium metal or uranium dioxide fuel elements without significant loss of uranium, although of the order of one per cent of the uranium may be converted to the insoluble and as yet unidentified green solid observed in the aforementioned experiments.

It has been found that treatment of this solid with caustic at elevated temperature results in rapid conversion to a compound readily soluble in nitric acid. This suggests the possibility that a caustic treatment following a dejacketing operation with ammonium fluoride may convert all the uranium to nitric acid soluble and fluoride-free forms amenable for processing in existing plants.

The effect of concentrations of ammonium, fluoride, and hydrogen ions on the dissolution of zircalloy-2 are shown in Table III.

TABLE III

RATE OF DISSOLUTION OF ZIRCALLOY-2 IN BOILING AMMONIUM FLUORIDE SOLUTIONS

M NH_4^+	M F^-	M Cl	M NO_3^-	Initial pH	Initial Penetration[a] Rate (mils/hr)
			Effect of NH_4^+		
0.10	1.0	1.0	---	7.0	0.07 - 0.12
0.50	1.0	1.0	---	7.0	0.31 - 0.96
0.50	1.0	---	1.0	6.9	0.55
0.80	1.0	1.0	---	6.9	11.0
0.70	1.0	---	1.0	7.0	5.9
1.0	1.0	1.0	---	6.9	19.0
1.0	1.0	---	1.0	6.8	14.0
2.0	1.0	1.0	---	6.9	19.0
2.0	1.0	---	1.0	6.8	13.0
			Effect of F^-		
2.0	0.25	---	1.75	6.8	4.8
2.0	0.25	1.75	---	6.8	5.9
2.0	0.50	---	1.5	6.8	8.2
2.0	0.50	1.5	---	6.9	11.0
2.0	1.0	---	1.0	6.8	13.0
2.0	1.0	1.0	---	6.9	19.0
2.0	2.0	---	---	6.9	27.0
			Effect of pH		
2.0	1.0	---	---	9.5	3.5
2.0	1.0	---	1.0	6.8	13.0
2.0	1.0	---	1.2	5.5	26.0
2.0	1.0	---	1.5	4.6	56.0

(a) Obtained by extrapolating plots of rate versus time to zero time.

The rate of the dissolution reaction varies quite rapidly with the concentration of ammonium ion in the range 0.5 to 1.0 molar ammonium but less rapidly at ammonium ion concentrations less than 0.5 molar or greater than 1.0 molar.

The dissolution appears to be approximately first order in fluoride ion but is considerably less than first order in hydrogen ion.

Formation of a dark coating on the zircalloy coupons is generally observed in these studies, and an experiment was done to determine the extent to which the

dissolution is affected by this coating. The rate of dissolution appeared to be virtually unaffected by the coating. Exposure of a coupon to boiling six molar ammonium fluoride for one hour resulted in an average penetration rate of 31 mils/hr. By comparison, the average dissolution rate was 33 mils/hr when the reaction was interrupted and the black coating removed mechanically four times during a one-hour period.

Further work contemplated on this problem includes studies aimed at elucidating the mechanism of dissolution of zircalloy-2 by ammonium fluoride, the behavior of plutonium in this operation, and the behavior of alloys of zirconium and uranium.

CAUSTIC SCRUBBER STUDIES

A six-inch-diameter bubble cap caustic scrubber with six trays at two feet spacing was operated to measure efficiencies for iodine removal. Twenty-five weight per cent NaOH was used as the scrubbing solution. A concentration of 500 ppm iodine in air was used as the feed vapor. Greater than 99.9 per cent of the iodine was removed from the gas.

No plugging difficulties have occurred in 80 hours of operation.

Entrainment of caustic in the exhaust gas stream was excessive in early runs. To eliminate this difficulty the vertical distance at the top of the tower between the gas outlet and scrub inlet was increased to two feet.

Flurex Studies

Solid Cathodes

The following materials have been studied as possible cathode materials for a Flurex cell: Hastelloy C, tantalum, monel, nickel, lead, gold, gold amalgam, copper amalgam. The materials were in the form of rods or sheets. Catholyte composition was 0.2 M UO_2F_2 - 1 M HF - 0.05 M NH_4F and temperature was maintained at 25-30 C. Current densities ranged from one to two amp./in.^{2} Very little if any reduction of uranyl ion was obtained with any of these materials; the principal cathode reaction was the discharge of hydrogen. Where reduction did occur, an adherent green-black deposit (UF_4?) quickly formed on the cathode surface. Several other materials which, according to the literature, may be used to effect difficult reductions remain to be tried. These include tantiron, chromiron, zinc, tin, and several amalgams. However, even though reduction with any of these materials is efficient, the problem of deposition of UF_4 on solid surfaces is a serious one. In a run involving an unstirred mercury pool cathode, current efficiency was only 36 per cent as compared to from 90 to 95 when the mercury was stirred. This experiment emphasizes the need for a renewable cathode surface for efficient reduction.

Mercury Cathode Arrangement

Several mercury cathode designs intended to approximate parallel arrangement of cathode and ion permeable membranes and, in consequence, produce nearly uniform current density in the membranes are under consideration. A laboratory model involving horizontal and parallel mercury pool cathode, cation and anion transfer membranes, and platinum cathode has been constructed and operated. The laboratory-scale model performed satisfactorily. Scale-up problems anticipated for this type cell include elimination of effects due to pressure differences between cell compartments and removal of gases which collect at membrane surfaces.

Consideration has been given to an arrangement wherein the anode and membranes are arranged vertically and parallel. The mercury cathode consists of a series of small troughs situated one above the other and so spaced as to realize nearly uniform current density in the cation exchange membrane. A cell of this design is under construction and will be tested during the coming month.

Conductivity Measurements

The overall cell resistance of a laboratory-scale Flurex cell was measured when using various combinations of cation and anion exchange membranes. These data were used to check the validity of calculated resistance based on conductivity values for individual cell components as reported last month. Correspondence between calculated and measured values was good in most cases. A noticeable exception involved Permutit 3142 as the cation exchange membrane. Here the calculated value was about 3.5 times the measured value. The difference is attributed to the observed tendency of Permutit 3142 to decrease in resistance in use. The present data indicate this membrane to be as good as Ionics CR-61 from a conductivity standpoint.

CONTINUOUS METAL DISSOLUTION

Four runs were completed during the month in the two-inch-diameter continuous tower dissolver. Slanting the tower at a 30° angle to aid gas dissipation was found to have no appreciable effect on the dissolution rate. It now appears that dissolution rate is more closely correlated by total nitrate concentration of the product than by acidity of the product. On the basis of total nitrate correlation current results agree with previous continuous and batch dissolving studies.

WASTE TREATMENT AND BY-PRODUCT RECOVERY

Cesium Recovery

The laboratory work on cesium packaging flowsheets applicable to the cesium zinc ferrocyanide process was completed and a formal summary report, "Cesium Packaging Studies; Conversion of Cesium Zinc Ferrocyanide to a Stable Product," J. L. Hepworth and R. L. Moore, HW-48832 (Confidential) was prepared.

Additional new information was obtained on the decontamination obtained in the previously reported electrochemical process for removing iron, zinc, and lead from dissolved cesium zinc ferrocyanide. The decontamination factors were unity (no removal) for zirconium-niobium, cerium-praseodymium, and strontium-yttrium, and five for ruthenium-rhodium. In other experiments, it was found that the deposited iron, zinc, and lead could be readily removed from the mercury cathode by washing with about 2 M nitric acid, thus regenerating the mercury for reuse.

Two other reports dealing with cesium recovery were also issued during the month and a third is in final form. These are: "Radiochemical Data and Calculations Concerning Principal Fission Products," H. H. VanTuyl, HW-48461 (Secret); "Recovery of Cesium from Purex Plant Wastes by Metal Ferrocyanides and Ferricyanides, I. Tracer Scale Laboratory Investigations," H. H. VanTuyl, HW-48829 (Confidential); and "Recovery of Cesium from Purex Plant Wastes by Metal Ferrocyanides and Ferricyanides, II. Full Level Laboratory Investigations," H. H. VanTuyl, HW-48830 (Confidential).

Neptunium Recovery

The difficulty of recovering neptunium(V) was confirmed by a mini run employing a high acid flowsheet as follows:

HAF: 1.35 M U, 30.0 M HNO_3, Flow = 100

HAS: 4.0 M HNO_3, Flow = 67

HAX: 30% TBP in Soltrol 170, Flow = 366

Although an aqueous phase acidity of about five molar nitric acid existed through most of the extraction section with this flowsheet, it resulted in recovery of only about 38 per cent of the neptunium(V) introduced in the feed.

For purposes of furnishing a flowsheet to the Chemical Processing Department by May 1 for cost estimation, work is being concentrated on recovery of neptunium from HAW by solvent extraction, followed by stripping and ion exchange isolation. The advantage of this flowsheet is that the main line Purex process is not altered or effected and that the recovery and decontamination of plutonium and uranium are in no way impaired. Basic chemistry is also sufficiently well understood at this time to insure that such a scheme will work. Mini runs are currently being carried out to test flowsheets drawn up by Engineering Development Planning personnel on the basis of laboratory equilibrium data. In the first run, NA Column flow ratios were feed: scrub: extractant = 150:100:390 (based on a Purex feed flow of 100). The HAW was butted to 3 M nitric acid, scrub was 1 M, and the extractant was 30 per cent TBP-Shell E2342. Feed and scrub were 0.01 M in ferrous sulfamate. NC strip was 150 volumes of 0.01 M nitric acid. Neptunium losses in each column were only about 0.2 per cent, implying an overall recovery of about 99.5 per cent. Continuing runs will establish the decontamination from fission products (particularly zirconium) as well as demonstrating the flowsheet on full level plant HAW.

The strip solution from the NC column would be concentrated and the neptunium further purified and decontaminated by adsorption on an anion exchange resin. Data is not yet available on resin column tests; however, the results of batch equilibrium tests are shown in Table I. The results are in good agreement with published ORNL data.

TABLE I

ADSORPTION OF NEPTUNIUM(IV) ON DOWEX 1 AS A FUNCTION OF NITRIC ACID CONCENTRATION

All solutions 0.01 M ferrous sulfamate. Resin = Dowex 1 x 10

M HNO_3	Distribution Coeff.*
4	275
5	690
6	1190
7	1870
8	2450
9	1780

* Distribution Coefficient = $\frac{Np^{239}\ c/m/gm\ Resin}{Np^{239}\ c/m/ml\ Solution}$

Other experiments (in 6.1 M nitric acid) showed that hydroxylamine and semi-carbazide are not as effective as 0.01 M ferrous sulfamate for reducing neptunium to the (IV)

Semiworks Waste Self-Concentrator

The waste concentrator returned to boiling at an accelerated rate during the report period. During the month, a total of 372 liters of condensate were collected and cribbed, reducing the liquid level in the tank to approximately 11 feet. This corresponds to 26 per cent of the original volume charged to the tank. The accelerated boil-off rate is believed due to recent modifications made in the condensate collection and measuring system. These changes essentially eliminate the reflux of condensate back to the tank. Assuming that the present boil-off rate will diminish slightly (continued fission product decay) during the next two months, the waste volume should be reduced to approximately 20 per cent of the original volume (equivalent to 25 M sodium ion concentration) by the completion of the maintenance program in June.

Nine "bumps" were recorded during the month. In each instance, approximately 13 liters of condensate were collected and the tank remained pressurized for about 100 minutes. The bumps originated, as determined from temperature profiles, at the 4-5 foot level in the concentrate. However, two distinct pressure patterns were evidenced. Four of the bumps developed maximum pressures of 35 to 38 inches of water with peak condensate flows of 200-300 ml/min. The other bumps developed only 2-4 inches of water maximum pressure with maximum condensate rates of about 50 ml/min. Operation during the entire month was with the 1/2-inch vapor header valve open. The boil-off rate between bumps averaged 6.3 ml/min.

Neptunium Recovery

Analytical effort continued in support of Chemical Research studies attempting to follow Np-237 in the Purex Process. Analysis was preceded by several decontamination cycles using thenoyl trifluro acetone (TTA) extraction of Np-IV. Tracer Np-239, a beta emitter, was used to determine Np-237 chemical yield. The finally isolated Np-237 contained a minor amount of foreign alpha activity. The following data demonstrate typical effectiveness of the chemical separation:

Plant Material	Np-237 Chemical Yield	Fraction of Separated Alpha Activity due to Np-237 (Measured by α-energy analyzer)
Purex IAF	45%	80%
UO_3	75	70

Measurements of Np-237 in UO_3 were made to support both Chemical Research and Process Chemistry (CPD) examinations.

Disposal to Ground

Soil equilibrium experiments were conducted with A-3 waste, a silica gel regeneration effluent from Purex plant. The results indicated reasonably good adsorption of plutonium by soil but very little adsorption of cesium and strontium. No immediate contamination of ground water by this waste is likely since the total volume discharged to the crib as of February 1, 1957, amounted to only about 50 per cent of the specific retention capacity of the crib. If however, future production plans involve continued use of the silica gel facility, additional studies should be made to estimate the "life" of the crib and to investigate possible alternatives to the present disposal procedure.

Approximately 500,000 gallons of TBP scavenged waste supernate having a Co^{60} concentration greater than 4×10^{-4} uc/cc were discharged to the 216-BC trench-site during the month. This brings the total volume of scavenged waste disposed on a specific retention basis at this site to 10.5 million gallons. Another batch of waste (54-106-BY) having a Co^{60} concentration below 4×10^{-4} uc/cc is being held in tank storage pending results of soil column tests evaluating cesium and strontium adsorption.

Document HW-48862, "Disposal of High Cobalt-60 Scavenged Wastes" was issued recommending normal crib disposal on a "use test" basis of scavenged wastes having a Co^{60} concentration below 4×10^{-4} uc/cc (previously recommended cribbable limit was 4×10^{-5} uc Co^{60}/cc) and demonstrating satisfactory strontium and cesium soil adsorption. The 216-BC cribs were recommended as the disposal facility. It is expected that the test disposal will yield data useful in establishing future ground disposal policies and also result in considerable savings by eliminating the need for constructing much additional specific retention trench facility.

The consequences were studied of diverting Purex steam condensate from the A-6 crib to the Purex Swamp. It was recommended that the steam condensate could safely be diverted if continuous monitoring were provided and rapid corrective action taken in the event of significant leaks. The Swamp would then be protected from excessive contamination.

Observation Wells

Trace concentrations of nitrate ion and radioactive material appeared in wells one to two miles south and southeast of 200 West Area. Tests revealed that this material could not have originated in the large volume cooling water streams that sustain the 200 West ground-water mound and must therefore represent intermediate level wastes disposed to cribs in 200 West Area. It is estimated that this represents an average rate of travel of up to 40 feet per day. No significant change in the extent of ground contamination resulting from movement from T-Plant disposal sites was apparent. As this material reaches areas of higher aquifer permeability and more rapid movement the contamination "front" would be expected to become more diffuse and difficult to detect. Significant concentrations of nitrate and trace concentrations of radioactive material were found in the ground water northwest of 200 West Area, in some cases north of Gable Butte. Such material must originate in 200 West Area, but a clearer understanding of the basalt structure in this region is needed to determine the path of travel and predict the ultimate effect of this movement.

It is believed that trace concentrations of radioactive material and nitrate ion appearing in ground water samples from wells north and south of Gable Mountain result from northward movement of ground water contamination from the BY-cribs in the 200 East Area. Significant concentrations of radioactive material were reported for samples collected from a well in the old Hanford townsite. This may represent the eastward progress of the material in the ground water on the north side of Gable Mountain or possibly may be originating in the 100-F Area.

Radioactive contamination in the ground water beneath the A-8 crib near the Purex Plant increased tenfold in a 30-day sampling period. This definitely confirms the A-8 crib as the source of the contamination and is indicative of the progressive utilization of the disposal capacity of the crib. Maximum concentrations detected in the ground water at this location exceeded 2×10^{-3} uc/cc.

Further field research was conducted to investigate vertical stratification of high-salt wastes in the ground water. A well in 200 East Area monitoring ground water contamination from the BY scavenged waste disposal cribs demonstrated a gradual increase in the concentration at 30 feet beneath the ground water surface while surface concentrations remained uniformly low. The concentration at 30-foot depth is now 2000 times that at the surface of the water table.

Special Geological Studies

The fixed price portion of the CA-700 (FY-1957) Chemical Effluents Technology drilling program was awarded to the Hatch Drilling Company of California for $7.40 per foot for the 5,400 feet. The price is the lowest yet quoted for well drilling at Hanford and climaxes two years of effort to reduce drilling costs from the high of $15.91 per foot paid two years ago. Use of Kai-well "hard-red" steel casing instead of the mild steel Schedule 30 casing permitted a bid nearly 7 per cent lower than that based on the latter. The thinner walls of the Kai-well casing will assure better perforations in the ground and greater sensitivity to radiation detection devices in the wells. Greater corrosion resistance will minimize rust in the well waters thus aiding the analytical work and the use of slip collars will provide greater joint strength than currently available.

Ground Water Control

A single-well pumping test was performed in the region south of Gable Mountain proposed for a new Purex Swamp site (CA 683). The test was designed to correlate with other aquifer evaluation tests conducted in this region and to measure the value of single well pumping tests. The data obtained from this test supported the determinations made in previous tests. The aquifer in the test area has a very high capacity for transmitting water.

Process Development

The investigation to determine the feasibility of using ion exchange resins for the disposal of low salt, radioactive waste effluents was continued. Synthetic A-8 effluent was fed to a resin column containing Duolite C-3, a phenolic methyl sulfonic acid cation exchange resin. The preliminary results indicated that more than 1500 column volumes of synthetic waste passed through the column without producing a breakthrough of Sr^{90}. Plans were made to repeat the experiment with actual A-8 waste to obtain a realistic capacity value for the resin.

The adsorption of ruthenium tetraoxide from carbon tetrachloride solutions by silica and alumina was investigated for concentrations of the tetraoxide that were higher than those used heretofore. The adsorption isotherms indicated the formation of a monolayer followed by a multilayer adsorption. The amount of ruthenium tetraoxide adsorbed per gram of adsorbent was much greater for the alumina than for the silica; this difference was tentatively attributed to the greater surface area of the former.

Gelling of Wastes - Field Work

A program to demonstrate field disposal of coating removal waste as an aluminosilicate gel was developed. Completion of "cold phase testing" is expected by August 15, 1957 and completion of "hot phase testing" was set for December 1, 1957.

Current work is concerned with establishing equipment and chemical requirements with emphasis being placed on designing satisfactory mixing and discharging equipment for use in the tests.

ANALYTICAL CHEMISTRY AND IN-LINE ANALYSIS

Mass Spectrometry

The first test runs of the thermal emission mass spectrometer were made with a sample of lanthanum and the $La^{138}O^{16+}$, $La^{139}O^{16+}$, and $La^{139}O^{18+}$ mass peaks were obtained in approximately their correct ratios. After initial alignment of the mass spectrometer and calibration of the analyzer magnet field, uranium samples with various degrees of U-235 enrichment were used to study resolution and precise analysis methods in more detail. At present the electron multiplier current ratios provide more precise U-235, U-238 ratios than the pulse or ion counting technique. The predominant uranium ion collected is UO^+.

The sample is mounted on the source filament as a nitrate salt and then evaporated to dryness and ignited. A complete sample change requires about two hours of elapsed time.

Emission Spectroscopy

In recent weeks, several minor sources of instability in the electronics of the direct reading equipment were corrected and collector photo-multiplier current ratios were then measured using steady excitation sources, such as incandescent lamp, and pulsing sources as mercury vapor lamp and a stoboscopic lamp. All of these tests gave collector multiplier current ratios which were reproducible within $\pm$ 0.3 per cent at the 95 per cent confidence level. On the other hand, current ratios obtained by spark excitation of aluminum and AlSi alloy samples gave poor reproducibility, with precisions ranging from $\pm$ 5.4 to $\pm$ 10.5 per cent. The tentative conclusion that the source excitation unit lacks the inherent stability needed for high precision spectrometry was confirmed by consultation with the spectroscopists of the Kaiser Aluminum Company laboratories in Spokane, Washington. A high precision spark excitation unit, available commercially, has been shown in unpublished work in other laboratories to be necessary for the type of results desired.

Gamma Absorptometer for Uranium Analysis

A laboratory analysis type gamma absorptometer with an Am-241 source has been assembled and is being applied to the routine analysis of uranium solutions in the range of 1 to 100 g/l. With a three cm cell length, a precision of analysis of $\pm$ 0.3 g/l (95 per cent confidence level) was indicated from preliminary data in the range of 1 to 100 g/l uranium. A secondary purpose of the study is to obtain data in support of gamma absorptometry as a close-coupled analysis method in the pilot and production plants.

Controlled Potential Coulometry

The controlled potential coulometric titration of uranium previously reported was re-examined experimentally after the apparatus had been rebuilt using higher precision components. Uranium was detectable to two micrograms, or 0.002 g/l in a one ml sample, while the analytical precision was about $\pm$ 0.2 per cent (95 per cent

confidence level) with two mg of uranium. After a brief study of the polarography of ferric ion in several media, coulometric titrations were studied with Fe^{+++} in a citrate-citric acid medium. With four mg of iron, an analytical precision of ± 0.2 per cent was obtained. Plutonium will be included in future studies.

Enriched Uranium Isotopic Analysis

The gamma count method for the determination of U-235 in enriched uranium, which was discussed in previous reports, has been applied to the determination of the U-235 content of each of a group of nine Savannah River uranium, aluminum alloy slugs (corresponding approximately to HAPO "C" slugs). The total dissolution of the slugs and total uranium determinations had been performed by Analytical Laboratories personnel. Five aliquots of each of the nine original solutions were gamma counted to a precision of better than ± 0.5 per cent at the 95 per cent confidence level (pure counting statistics contributed ± 0.16 per cent). The gamma counts per gram equivalent of uranium was computed using the total uranium analysis data, and per cent U-235 for each slug will be calculated relative to a standard with an overall precision of ± 0.8 per cent of the U-235 value. The method will also be used to analyze a similar group of Hanford "C" slug "standards".

SEPARATIONS PROCESSES

Plutonium Impurity Measurements

Plutonium solutions were charged with impurities and submitted for spectrographic analysis. Reported chromium and nickel measurements were low by a factor of ten. The error is not a flyer and is in real conflict with former accuracy statements for the analysis of plutonium metal impurities by carrier concentration. (Daniel, J. L, "Spectrochemical Analytical Method for Plutonium in the 300 Laboratory," HW-43353, March 6, 1956 (Confidential Undocumented)). Analytical Control, Finished Products Operation, CPD, also uses the same method. At present the method is useful only for relative values; metal plutonium product assay obtained by subtracting spectrographically determined impurities, for example, is now highly questionable. Chemical Instrumentation and Spectrochemical Analysis are cooperatively trying to solve the problem. Uranium-base standards are being replaced with plutonium-base standards. New pretreatments under consideration are (1) expanded use of TTA extraction to separate impurities and (2) separation of impurities by plutonium anion exchange.

Contact Alpha Counter

A number of zinc sulfide phosphors including solid dot, annular, polka dot, and spiral configurations have been made and are being life tested by exposure to 2 M HNO_3 solution. The film used to protect the phosphor from the acid is 0.00025-inch-thick Teflong in all cases. After ten days, all phosphors retained their original condition.

An open center sample cell using a one-half-inch-diameter, dot-type phosphor was tested extensively during the month. The monitor assembly was positioned with the phosphor at the cell bottom, so that it was completely covered even though the cell was running only partly full. Under these conditions, the adherence of alpha activity to the protective coating was equivalent to a solution concentration of 0.030 gram of plutonium per liter. After contacting the cell and phosphor with solutions of increasing plutonium concentration (0.06, 0.12, 0.24, 0.6, and 6.0 grams per

liter), it was possible to again detect a concentration of 0.03 gram per liter after a single water rinse equal to about two cell volumes or roughly twenty milliliters. The counting rate ranged from 3.2×10^5 counts per minute at 6.0 grams per liter to 3.5×10^3 counts per minute at 0.06 gram per liter. From these data, it is clear that the phosphor configuration, size, and density can be selected to give optimum counting rates for normal operation in a particular application.

Pu Resin Column Controls

Reservoir Level Indicator. Laboratory and semiworks tests of the resin level indicating system for the reservoir section of the continuous ion-exchange column have been completed.

The indicating system, including the reservoir spool piece, is now installed in the plant. The operation of the instrument during plant shakedown runs has thus far been entirely satisfactory. It has reliably located and indicated the resin level within the specification of $\pm$ 1/2 inch.

C-Column Acid - Water Interface Detector. The C-Column acid-water interface controller and conductivity probes have been installed in the plant. When removed from the semiworks prototype column, the instrument had been operating satisfactorily for approximately one month.

Resin Loading Absorptometer. The Ohmart unit for detecting the plutonium concentration on the resin at the feed point has been tested and calibrated using lead absorbers. The unit is calibrated to read 0 to 160 grams per liter of plutonium. A ten-day drift test showed a change in readings of $\pm$ 3 per cent. The repeatability of readings from day to day was $\pm$ 1 per cent.

The unit is now mounted on the feed section of the semiworks column and will be calibrated using uranium feed solutions.

Filter Photometers

The design for a self-degassing, dual-filter photometer system and for a nondegassing, dual-filter photometer system has been completed. Plant models will be built and tested as soon as possible. The self-degassing model will be tested under conditions simulating the Purex 1AF and 2DF sample streams. The nondegassing model will be tested under conditions simulating the Redox 2AF sample stream.

Commercially built light sources and photosensitive detecting devices have been placed on order for test purposes. These units have a possible application as standard components of filter photometer units, replacing similar plant fabricated devices.

Redox IAFS (F-1) pH Prototype

Modifications to the pH prototype were made to minimize the possibility of pressurizing the rinse and buffer lines during the standardization cycle. In the initial operations the rinse and buffer solutions were added to the cell by jet. This operation included the possibility of pressurization and back-up of radioactive solution into the "cold" reagent tanks. Attempts were made to add these solutions by gravity flow in the existing piping. However, the solutions flowed back to the

F-1 tank via the sampler suction leg rather than through the cell, jet, and return leg. Consequently, the piping is being changed to introduce the standard solutions downstream of the pH cell, which should cause the solutions to flow by gravity through the cell and sample suction leg back to the tank. This approach is preferred to adding additional valves or vacuum breakers.

EQUIPMENT DEVELOPMENT

Titanium Model-S Chempump

The shaft-impeller assembly has been redesigned to overcome the weaknesses revealed during previous tests. A total of 326 hours operation pumping 60 per cent nitric acid at 9.5 gpm against a head of 65.5 feet has been logged on the modified unit. Operation has been smooth and quiet.

Johnston Test Pump No. 1

A standard deepwell turbine pump equipped with a 3450 rpm motor was dismantled for inspection after 1102 hours of operation. The pump handled a variety of solutions during the test, some of which contained solids. The graphite bearings were worn 14 to 43 mils and the graphite vapor throttle bushing was worn 82 mils. In addition, the bearings were scored 10 to 20 mils deep. The journal wear was less than 0.5 mil; however, scoring to a depth of about 5 mils had occurred. Solids in the solutions probably caused the excessive bearing wear. Deepwell turbine pumps operating at 3450 rpm in clean solutions have not evidenced excessive bearing and throttle bushing wear.

Purex AF-15 Agitator

Life testing of the statically and dynamically balanced shaft-paddle assembly was discontinued after 11,700 hours operation. The test unit was returned to spare parts, since recent agitator failures in the Purex plant have depleted the spare agitator inventory.

Operating stability of the agitator was unchanged throughout the test period. This excellent behavior is contrasted with failure after 4994 hours of very rough operation obtained from an unbalanced, as-received agitator shaft. These two observations collectively demonstrate the value of straightening and balancing the agitator shafts before they are used in the operating plants.

Continuous Calciner Rotary Feed Valve

Continued successful operation of the three-inch-diameter, solid-body rotor feed valve (SK-2-43234) has gained plant acceptance of this valve. The Chemical Processing Department plans to install the valve on the operating calciners.

Plug Piston Pulsers

A ceramic piston and cylinder (Coors Porcelain Company aluminum oxide) were received. The parts fit exceptionally well, the diametral clearance ranges from 0.5 mil to 0.25 mil. The surface finish of the cylinder bore as determined with the Brush analyzer is 15 to 25 microinches. These parts will be evaluated as substitutes for pile graphite pistons and 17-4 PH stainless steel cylinders in the Hot Semiworks pulse generators.

Materials of Construction

Fel-Pro C-5. A high temperature pipe thread compound manufactured by Felt Products Company and used by some stainless steel fabricators was tested in threaded pipe connections which were immersed in various test solutions at room temperature for 38 days. After exposure to 60 per cent nitric acid and 50 per cent caustic soda, there was no visible evidence of any remaining compound; the connections separated readily. Test materials immersed in carbon tetrachloride, Purex, HAX, Recuplex CAX, and hexone had, upon separation, a normal amount of thread compound left on the parts. The parts also separated easily with no tendency to seize or gall.

Polyrubber #510. A moldable urethane polymer marketed by the American Latex Products Corporation was tested by static immersion at room temperature for 28 days with results listed below:

Solution	% Change Length	Durometer "A" Hardness(1) 28 Days	Remarks
60% Nitric Acid	--	--	Failed after 1 hour.
50% Caustic Soda	0	32	No visible change.
Carbon tetrachloride	-6	28	No visible change.
Recuplex CAS	--	--	Failed after 8 hours.
Purex HAX	--	--	Failed after 10 days.
Hexone	-6	25	No visible change.

(1) The original hardness of this material was 37 Durometer "A".

Hysol. A two part adhesive manufactured by the Houghton Laboratories was tested as a bonding agent between polyvinyl chloride and silicon carbide for use in a solution of 4.2 M nitric acid and 0.1 M oxalic acid. In the service for which this material was being tested the silicon carbide would be cleaned periodically with a potassium permanganate-nitric acid solution at 55C and neutralized in a hydrogen peroxide -nitric acid solution. After 105 days in the test solution and two cleaning cycles, the glued joint did not fail; however, there was a failure of the silicon carbide adjacent to the glued joint. The load which could be supported decreased as the test progressed until the final sample would not support 30 psi. Failure of the silicon carbide is probably the result of tension set up by shrinkage of the glue. The remainder of the silicon carbide was not noticeably affected. The data indicate that the load which this joint will support is a function of time more than environment.

Corrosion Studies

Corrosion of Stainless Steels in NH_4F Solutions. Recent studies have indicated useful rates for dissolution of zirconium in NH_4F (4M). While several Ni-Mo alloys would be suitable materials of construction for this process, they would not be suitable for a subsequent nitric acid dissolution of uranium. The corrosion

resistance of types 304-L and 347 stainless steels to ammonium fluoride solutions was studied. Weight loss measurements on coupons of these materials (sensitized at 1250 F) totally immersed in boiling 4 M NH_4F (pH~7) indicated corrosion rates of about 5 x 10^{-4} inches/month. Pitting attack characteristic of halogen acids was absent. Local attack at points where the coupons were scratched to destroy the passive film has not been observed.

Corrosion of annealed 347 stainless steel in 4 M NH_4F was measured with the Corrosometer. This instrument, a recent addition to Hanford Laboratories, determines corrosion rates continuously by measuring changes in conductance of the corroding sample. Corrosion rates as low as 10^{-4} inches/month can be determined accurately in a two to four hour exposure. Rates of 2.3 x 10^{-4} and 2.0 x 10^{-4} inches/month were observed for the annealed 347 stainless steel in 4 M NH_4F and 4 M NH_4F - 0.01 M HNO_3, respectively. Sparging the solutions with air or helium did not alter appreciably the corrosion rates. A study of corrosion rates for 304 L and 347 stainless steels vs. pH and zirconium content of NH_4F solutions will be made.

Laboratory-Scale Heat Exchange Studies. Use of the laboratory-scale heat exchange equipment for determination of corrosion rates of various stainless steels and titanium in boiling nitric acid systems has been hampered by crevice corrosion due to concentration cells formed at the sample-Teflon gasket seal. This phenomenon was not observed when the units were used for study of corrosion by Purex 2WW solution. None of the expedients tried so far (change in gasket design, different gasket material, silicone grease on gasket, increasing gasket loading, addition of inert salts) has completely eliminated the problem. Purging the corrodent (HNO_3) with helium reduced the magnitude of both crevice and general corrosion.

Mock-Up Heat Exchanger Studies (F-55 Pot). Bayonet heat exchangers of Types 446, 310 Cb, 16-2 manganese substitution, and 312 stainless steels have been exposed to boiling 60 weight per cent nitric acid continuously for about seven weeks. Exposure will continue to failure. A 304-L stainless steel and a type A-70 titanium bayonet have been exposed to boiling 60 weight per cent nitric acid at a steam temperature of 175 C for 28 days. Relative weight loss 304-L/Ti is about 700; corresponding to an apparent relative penetration rate of about 300.

Behavior of Chromium in Nitric Acid. Studies of the fate of Cr(III) and Cr(VI) in boiling nitric acid solutions were made in order to understand better the role of chromium in corrosion tests made in laboratory test equipment. In apparatus where cold finger condensers are used, Cr(III) is oxidized to Cr(VI) in boiling 65 weight per cent nitric acid while Cr(VI) is reduced to Cr(III) under capsule (FACT) conditions or where Fredricks condensers are used. Kinetic data for these reactions when using the above two types of condensers have been obtained.

Integrity of Kel-F Coatings. Of twelve mild steel samples which had been spray-coated with a Kel-F dispersion and submitted to this laboratory for evaluation, five were marked as having pinholes on the basis of visual examination. All twelve samples were exposed to boiling 65 per cent HNO_3 for 240 hours. One sample showed no evidence of pin holes. One sample had a liquid film under the coating but was not appreciably corroded. Ten samples showed extensive corrosion of the steel due to pinholes in the coating.

UO_3 CONVERSION

UO_3 Studies

Further studies of the oxidation-reduction treatment for improving the reaction behavior of uranium dioxide produced from uranium trioxide have shown that multiple cycles are beneficial in the hydrofluorination step. With repeated cycles, the particle size remains essentially constant as does the surface area. The bulk density, however, decreases continuously, substantiating the view that oxidation-reduction brings about a change in the physical composition of the crystal aggregates perhaps separating crystallites to the point that the occurrence of sintering is rendered difficult.

Further experiments to determine optimum conditions for activation by this method have established the best oxidation temperature at 540 ± 40 C with air, and the best reduction temperature at 650 ± 50 C with hydrogen diluted to 100-200 mm Hg with nitrogen or steam.

CONTINUOUS CALCINATION

The 16-inch-diameter by 8-foot-long continuous calciner was operated to: (1) hydrate and dehydrate five tons of continuously produced UO_3 and (2) to produce five tons of sulfur-free UO_3. Both lots will be shipped to K-25 for pilot plant studies.

The hydration operation was carried out by feeding continuously produced UO_3 obtained from 224-UA Building through the calciner and injecting water through the feed points normally used for UNH. Bed temperature and shell temperature were maintained at 75 and 120 C, respectively. Water content of the hydrate averaged 6 weight per cent. Reactivity data are not available.

The hydrate was passed through the calciner with the bed temperature kept at 350 C for dehydration. The water content of the UO_3 was reduced to 0.7 weight percent.

The sulfur-free calcination run was made in the routine manner with feed point temperatures of 260 C.

HOT SEMIWORKS MAINTENANCE ACTIVITIES

The current maintenance program at the Semiworks is 75 to 80 per cent completed. Inspection and testing of the A Cell floor is nearing completion. The work remaining on the wall-cover-skirt (secondary leakage seal on the wall) will be completed within the next two weeks. Process line revisions within A Cell are 75 per cent completed. Gasket replacement is 90 per cent completed.

All the pulsers have been installed in B Cell and the overall B Cell program is 95 per cent completed.

In C Cell some efforts were expended in decontaminating floor "hot" spots. In addition some piping revisions and gasket replacements were made.

The Raschig rings in the No. 1 and No. 2 acid concentrator towers were found to be badly corroded. In some rings the wall had actually been corroded through. The corrosion is believed to result from the traces of fluoride ion which accumulate

in the acid waste concentrators upon startup after decontamination periods. (During decontamination efforts a 3 per cent NaF and 20 per cent HNO_3 solution is used for final cleanup.) The corroded rings are being replaced with "thick-wall" rings. In future operations tower corrosion will be minimized by modifying flushout and operating procedures.

3000 PROGRAM - WEAPONS

An improved emission spectrographic method utilizes a service instrument to measure ten parts of gallium in one million parts of plutonium. Precision is - 10 per cent, 95 per cent CL. The former method required a research instrument and had a detection limit of 200 ppm. The new limit meets urgent requirements of Weaponization Development.

4000 PROGRAM - REACTOR DEVELOPMENT

PRPR

UO_2 particle size determination was satisfactorily accomplished by the Andreasen sedimentation pipet method. Earlier discrepancies were removed by using Daxad-23, deflocculating agent suggested by Fuels Development.

In collaboration with Atmospheric Physics Operation estimates were made of permissible leak rates of the containment structure of the Plutonium Recycle Reactor. It was determined that leak rates in excess of 100 cubic feet of gas in one hour would probably be serious to personnel in the vicinity in the event of complete release of reactor contents to the containment structure. Recommendation was made that a 200 foot stack be provided, primarily for protection of facilities and personnel located near the reactor site and for safely releasing fission debris from minor incidents in preference to containment.

MISCELLANEOUS

Impregnated Graphite Fuel Material

The method for impregnating graphite with uranium oxide described in HW-48741-C, was modified by inclusion of a step after the rinse, in which the graphite cylinder is rotated rapidly on its axis. The calcination temperature was also raised from 600 C to 1000 C. Using this technique, a two gram cylindrical sample of pile graphite, one centimeter in diameter, was impregnated successively through 11 cycles. The weight change increased regularly to yield a final loading of 525 mg U/cm^3, probably as U_3O_8.

Analyses of the uranium from the leaching of concentric shells machined from a cylinder loaded to an average of 45 mg U/cc showed a high peripheral concentration with relative uniform distribution through the core. In the outermost shell consisting of about 49 per cent of the sample, by volume, the average concentration was 55 mg U/cm^3; in three inner shells comprising 35, 10, and 6 per cent of the volume, respectively, the average concentrations were 30, 28, and 29 mg/cm^3. Material balance was 95 per cent.

This technique is evidently suitable for preparing representative materials of this type. It will, therefore, be used to impregnate graphite with plutonium so that the processing of this material may be studied.

UO_2 Improvement Studies - Ceramic Fuels

Uranium dioxide derived from HAPO continuously calcined UO_3 was reoxidized and reduced in the two stage fluidized bed unit. Its sintering properties were then examined by Ceramic Fuel Development Operation personnel and was found to be markedly improved by exposure to the cycle (see accompanying table). As a result of this improvement, a 26 pound sample of Mallinckrodt Chemical Works UO_2 was subjected to a similar oxidation-reduction cycle, and the sintering properties were studied. Again, a decided improvement was observed which was correlated with a large increase in surface area (250-300 per cent) resulting from the oxidation-reduction treatment. This process offers definite promise for production of a uniform uranium oxide with well defined sintering properties.

TABLE IV

EFFECT OF OXIDATION-REDUCTION TREATMENT ON SINTERING CHARACTERISTICS OF UO_2

	Extruded		Pressed	
	Green Density	Fired Density	Green Density	Fired Density
Untreated Hanford UO_2	----	----	58.3	84.2
Treated Hanford UO_2	52.5	88.5	57.7	93.6
Untreated MCW UO_2	56	83-86	62.5	87
Treated MCW UO_2	57	92	62	91 (?)
Best Ceramic Grade UO_2	54.5	94.5	63	97.5

Processing PRPR Fuels by TTA Extraction

A preliminary study of the radiolysis of TTA-benzene solutions was made in order to ascertain if radiation damage to the solvent would pose severe problems in processing PRPR fuels by extraction into TTA-benzene.

Prolonged exposure to cobalt-60 radiation and to plutonium alpha radiation results in destruction of TTA, as inferred from the fact that distribution coefficients for both plutonium(IV) and plutonium(III) into TTA-benzene solutions are significantly lower after irradiation. These data are summarized in Table V.

TABLE V

RADIOLYSIS OF 0.05 M TTA IN BENZENE[a]

Radiation	Exposure (Watt-hr/liter)	Final M TTA[b]	m, moles TTA destroyed per watt-hr absorbed by solution
	0	0.05	
Co-60 gamma	62	0.035	0.24
Co-60 gamma	103	0.027	0.2
Pu alpha	0.64	0.0465	5.4
Pu alpha	1.64	0.042	4.9

(a) Irradiated while in static contact with 0.5 M HNO_3.

(b) Computed from measured values of E_a^o for Pu(IV) and expression

$$(TTA)_f^4 = (TTA)_i^4 (E_{a_f}^o / E_{a_i}^o)$$

The reason for the large discrepancy in apparent decomposition per watt-hr of alpha radiation as compared with gamma radiation is not understood. Further studies employing shorter gamma irradiations and independent means of following TTA concentration are contemplated.

Decomposition products of TTA and benzene produced by radiolysis apparently will not prevent stripping of plutonium(III) out of the solvent. The distribution coefficient for plutonium(III) between three molar nitric acid and a benzene solution initially 0.05 molar in TTA which had absorbed 103 watt-hr/l of gamma radiation was 6×10^{-5}. The concentration of plutonium remaining in this solvent after this equilibrium was only 5×10^{-5} grams per liter. Since one pass in the type of operation envisioned for PRPR fuels would result in an estimated beta gamma dose of only about 0.4 watt-hrs/l., loss of TTA is not expected to be a severe problem.

Formation of emulsions and of solids which tended to accumulate at the interface was observed in the prolonged gamma radiations (Table V) and probably represents the major process difficulty to be expected from radiolysis of the TTA-benzene solvent. Further work is required to estimate the magnitude of this problem.

6000 PROGRAM - BIOLOGY AND MEDICINE

Environmental and Radiation Chemistry

Radioisotopic analyses for Na^{24}, P^{32}, Sc^{46}, Cr^{51}, Cu^{64}, Zn^{65}, As^{76}, Ba^{140}, and Np^{239} were made on the filterable material from two Columbia River water samples taken during periods of low filterable solids content and high filterable solids content. Filterable solids collected January 23, 1957 on Whatman 41 had 5 per cent of the Zn^{65}, 8 per cent of the Cu^{64}, and about 25 per cent of the Sc^{46} present in the unfiltered water. Much larger amounts of radioisotopes were found on the high solids sample of February 27, 1957. After a Whatman 41 filtration, still more material was removed by Millipore (HA) filtration. The total filterable material (55 mg ash/liter of water) was found to contain 86 per cent of the P^{32}, 91 per cent of the Sc^{46}, 4 per cent of the Cr^{51}, 59 per cent of the Cu^{64}, 72 per cent of the Zn^{65}, more than 26 per cent of the Ba^{140}, and 6 per cent of the Np^{239}.

Samples of raw and sanitary water were taken on March 14, 1957, and analyzed for nine radioisotopes. The results are tabulated below:

	Radioisotopes ($\mu c/ml \times 10^6$)								
	Na^{24}	P^{32}	Sc^{46}	Cr^{51}	Cu^{64}	Zn^{65}	As^{76}	Ba^{140}*	Np^{239}
Pasco Raw Water	0.56	0.18	0.016	2.7	0.32	0.14	0.47	0.035	1.5
Pasco Sanitary Water	0.25	0.018	0.003	3.8	0.048	0.059	0.039	0.022	1.2
Kennewick Raw Water	0.59	0.23	0.011	3.9	0.34	0.15	0.57	0.010	1.5
Kennewick Sanitary Water	0.37	0.065	0.004	3.4	0.22	0.093	0.21	0.018	1.1
183F Raw Water	7.1	0.31	0.044	10	6.4	0.37	2.7	0.066	5.0
183F Sanitary Water	5.6	0.033	<0.002	9.5	1.1	0.19	0.14	0.043	4.9

*The Ba^{140} values reported in the February monthly report were in error and should have been 0.017×10^{-6} and 0.0098×10^{-6} $\mu c/ml$ for 183H raw and sanitary water, and 0.031×10^{-6} and 0.098×10^{-6} $\mu c/ml$ for 183F raw and sanitary water.

P^{32} and As^{76} are more efficiently removed by the Pasco and the 183F water plants than at Kennewick. Na^{24}, Cr^{51}, and Np^{239} are not removed very well by any of the water plants.

In the study to develop methods for measuring the radioisotope content of Columbia River aquatic life, 130 samples of various types of fish, insects, algae, plankton, and other aquatic forms have been analyzed using beta absorption and multichannel gamma spectrometry. The major radioisotopes measured in whitefish, carp, sucker, salmon, and crayfish are Na^{24}, P^{32}, Fe^{59}, Zn^{65}, Cs^{137}, and Np^{239}. Algae, plankton, and insects contain most of the reactor effluent water radioisotopes, and Mn^{54} and Fe^{59} were identified in these samples in addition to the 11 radioisotopes measured in a previous study.

Fe^{59} can be measured on reactor effluent water samples by multichannel gamma spectrometry after a 5-10 day decay period. Greater accuracy is obtained if about six weeks decay is allowed for removal of interference from Ba^{140}-La^{140}. A total of 11 radioisotopes can now be measured on a single reactor effluent water sample plated on a one-inch dish without any chemical separation.

Mn^{54} was identified as a contaminant in reactor effluent water, and a value of 1×10^{-7} $\mu c/ml$ was obtained on a sample taken January 29, 1957 from 107-H. The Mn^{54} was measured by gamma spectrometry after a chemical separation of manganese and a delay to allow the Mn^{56} to decay.

A TTA extraction procedure for separating Y^{90} from strontium carbonate has proved to be satisfactory for the analysis of the Sr^{90} content of very low activity environmental samples. The extraction procedure was compared with the strontium beta absorption counting method for estimating the Sr^{90} in a mixture of Sr^{89} and Sr^{90} with very good agreement on vegetation and rabbit bone samples. On soil samples the values obtained by the absorption counting technique were low. The extraction procedure is now being used in the study of the Sr^{90} in environmental materials.

The gray wedge system of pulse height analysis was tested for application to the determination of I^{131} in vegetation samples and found to be capable of a sensitivity greater than 5×10^{-6} $\mu c/gram$ when a 5" x 3" NaI(Tl) crystal is used to measure 100 grams of vegetation. A method of reading the 35 mm photographic negative of the spectrum is being sought to eliminate the necessity of photographic enlargement which would make the system less suitable for routine use.

Geology and Hydrology

Research continued on the evaluation of the influence of moisture content of a soil, expressed as "the approach to saturation" (ρ), in the gradient-flow relationship. The equation has been assumed to be of the form:

$$Q = -Kai\rho^c$$

Where
- Q = flow rate
- K = permeability for saturated flow
- A = cross-sectional area of flow
- i = hydraulic gradient (tension gradient)
- ρ^c = assumed form of the moisture content function

Theoretical considerations dictate that the exponant, c, should be close to 4 and should be independent of the nature of the soil tested. These conditions seem to be fully consistent with data so far obtained.

The work involves measuring the flow, gradient, and moisture content for a laboratory hydrologic model and solving for the exponent c. Runs were made by varying the above conditions on a given bed of soil in a vertical column model. Two sets of runs were made using two widely different kinds of soil, one a uniform washed sand, and the other a sandy soil containing appreciable quantities of silt and clay. The values of c obtained for the former averaged 4.1 and those for the latter averaged 4.2. The good agreement obtained for such dissimilar soils indicates the validity of the theoretical basis for the moisture content function chosen. When completed this work will furnish information to assist with determinations of the rate of vertical movement of liquid wastes downward from a disposal crib, and estimates of the effective volume of soil beneath the crib contacted by these liquids moving under unsaturated flow.

Model tests are also being conducted to give a firmer technical basis for the well dilution technique for measuring ground water velocities and to test electrolytes and instruments for application in the test; a large sand-box model is being used for the work. Preliminary analyses of the first data from this study reaffirm the validity of the Rowe Dilution Velocity equation, but indicate a poor correlation of test results with calculated velocities. The work is intended to modify the technique to permit the collection of ground water velocity data having a greater confidence level than has been possible previously.

The use of shaped-charge perforation of in-place well casing was reviewed with Health and Safety Operation. It was indicated that this method could be used if the necessary precautions were observed as in any other potentially dangerous operation performed routinely on the plant.

The U.S. Geological Survey was 400 feet behind schedule on the CA-700 (FY-1957) drilling program. A continuous rate of about 500 feet per month is necessary to complete their part of the work by July 1, 1957.

Soil Chemistry

Equilibrium experiments between solutions of radio-cerium and soils indicated that the removal of cerium is highly sensitive to pH and Ce concentration. For cerium concentrations of less than 10^{-4} M the per cent removal shows two pronounced maxima as the pH increases, one at about pH 7, the other at pH above 12. The shape of the pH vs. per cent removal curve led to the conclusion that two mechanisms are acting, each with its own pH dependence. The important mechanism operating up to pH 8 is believed to be ion exchange, since it is almost independent of ionic concentration at the low concentrations studied. The reaction occurring in the pH range above 9 is very sensitive to concentration and appears to result from a chemical reaction that changes the chemical form of the cerium.

The differential thermal analysis equipment for performing clay mineral studies was placed in operation on a test basis.

Diffraction patterns from certain clay fractions from the upper Ringold formation were studied. The patterns indicated mainly montmorillonite and calcite. The

appearance of calcite in the clay fraction explains the relatively low ion exchange capacity obtained for the fine material from this horizon.

The Gelling of Wastes

A sample of simulated aluminum coating waste was used to determine the optimum ratio of waste to silicate required to prepare a good quality gel. The quality of the gel was determined by measuring the amount of water that could be decanted from it after centrifuging for 5 minutes at 1000 rpm. As little as 0.4 volume of sodium silicate (40° Bé) to 5 volumes of aluminum coating waste produced a gel, but better properties were obtained by using 2 volumes of silicate to 5 volumes of waste. The gelling time for this latter mixture was approximately 3 minutes at room temperature.

An initial attempt to gel aluminum coating waste from Purex plant was unsuccessful due to a deficiency of free NaOH. Further experiments with the Purex waste demonstrated that a good quality gel could be produced by adding an additional 2 moles of sodium hydroxide per liter of waste before adding the sodium silicate. Further tests indicated that a minimum basicity of approximately 3 moles of sodium hydroxide per liter of waste in addition to the amount required to dissolve the aluminum is essential for gelation to occur.

The effect of heat on the aluminosilicate gel was investigated. Heating produced a chalky white solid stable up to the fusion point of approximately 950 C. The fused material formed a white porcelain-like mass after cooling; increasing the temperature of the melt to 1050 C before cooling produced a hard, clear, glassy material. These results show that the aluminosilicate product could be prepared in at least four different physical modifications with the choice of the best form for disposal dependent primarily on the economics of the preparation and the need for the end product to resist decomposition.

Monitoring Methods: Slug Rupture Detectors

The quantitiy of fission products entering the Columbia River from ruptures during 1956 was compared with that entering during 1952 to evaluate the need for more sensitive, quantitative detectors for control and inventorying of fission products released to the river. It was determined that in this period fission products from ruptures increased by a factor of about six. On the average during the past year the release of fission debris has resulted in an estimated concentration at Pasco of 0.6 per cent of the off-plant MPC for 24-hour decayed fission product mixture excluding noble gases. The increase in rupture debris resulted from more severe ruptures rather than from increased frequency.

y

O. A. Hall for
Manager
Chemical Research & Development

VR Cooper:bp

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
G. W. Watt	3/5-8/	University of Texas Austin, Texas	Consultant	JM Nielsen EE Voiland MT Walling HT Hahn RL Moore VR Cooper RE Burns	Yes
Mr. McAdoo W. Haass M. Griffel	3/5/	Westinghouse Pittsburgh, Pa.	Decontamination procedures	RJ Sloat	Yes
C. Postmus M. H. Studier	3/5-13/	Argonne National Lab. Lemont, Illinois	Project "C" technology and skills Discussions on radiochemical methods of analysis	EW Christopherson DM Robertson RJ Brouns RE Connally FP Brauer JM Nielsen	Yes
F. P. Baranowski	3/19/	AEC Washington Office Division of Production Diffusion Branch	Observe chemical processing equipment and discuss application of the HSW to Industrial Power Reactor Fuels Processing	RJ Sloat OF Hill RG Geier	Yes
N. H. Wood	3/21/	General Engineering Lab. Schenectady, New York	Equipment discussion	AE Smith	Yes
C. A. Slenning	3/22/	Minneapolis-Honeywell Co. Minneapolis, Minn.	Inspect a recording milliameter purchased from his company.	JF Honstead JR McHenry	No

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
J. Rein	3/21-22/	Phillips Petroleum Idaho Falls, Idaho	Discussed Inline Instruments Discussions on analytical methods and in-line instrumentation Preparing a paper on use of remote control equipment in analytical chemistry	GJ Alkire RJ Brouns JL Ryan EJ Wheelwright EW Christopherson DM Robertson FE Holt HJ Anderson	Yes

VISITS TO OTHER INSTALLATIONS

A. S. Wilson	3/1-7/	Knolls Atomic Power Lab. Schenectady, New York	Discussions with personnel of the Chem. and Chem. Eng. Div.	D Ahmann	Yes
J. C. Sheppard	3/2-8/	Oak Ridge National Lab. Oak Ridge, Tennessee	Attend conference on neptunium recovery	WK Eister	Yes
W. H. Reas	3/3-6/	AEC Office Washington, D.C.	Attend AEC sponsored meeting on power reactor fuels reprocessing	AJ VanderWeyden	Yes
V. P. Kelly	3/11-12/	Union Carbide Nuclear Co. X-10 Site Oak Ridge, Tennessee	Discussed fuel elements and remote handling at Oak Ridge	C Watson	Yes
	3/13/	Nuclear Systems Division The Budd Company Philadelphia, Penn.	Discussed isotope packaging		No
	3/14-15/	Philadelphia, Penn.	Attend Hot Labs Conference and the Equipment Exposition in connection with the Hot Labs Conference.		No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
K. H. Hammill	3/13-16/	Philadephia, Penn.	Present paper at the Hot Lab Conference		No
F. M. Smith T. R. Cartmell	3/20/	Kaiser Aluminum Company Spokane, Washington	Consultation on analytical methods	DA Brewster	No
O. F. Hill	3/26-29/	UCLA Los Angeles, California Cal. Tech. Pasadena, California	PhD Recruiting Trip		No
P. P. Rowe	3/26-31/	US Bureau of Reclamation & USGS Hydrologic Labs. Denver, Colorado	Inspect hydrological experimental facilities	AI Johnson LN McClellen	No
J. R. Raymond	3/26-29/	Bureau of Reclamation Denver, Colorado	Examine hydrological lab equipment for possible application at HAPO	LN McClellen	No
R. L. Moore K. H. Hammill W. H. Reas	3/27-29/	Phillips Petroleum Co. Idaho Falls, Idaho General Electric Co. Idaho Falls, Idaho	Consultation on high level radiochemical facility " "	CM Slansky RE Scott	Yes Yes

BIOLOGY OPERATION MONTHLY REPORT - MARCH 1957

A. Organization and Personnel

No major or significant items relating to personnel changes or personnel activities occurred during March 1957.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Samples of terrestrial and aquatic organisms are routinely collected and assayed for radioactive contaminants released to the atmosphere, impoundments, and the Columbia River.

Atmospheric Contamination

Concentrations of I^{131} in the thyroid glands of rabbits are tabulated below, in decreasing order:

Collection Site	$\mu c\ I^{131}$/g thyroid Average	$\mu c\ I^{131}$/g thyroid Maximum	Trend Factor
Meteorology Tower	5×10^{-3}	1×10^{-2}	-
East of 200 East Area	4×10^{-3}	6×10^{-3}	-
One mile SE of Redox	3×10^{-3}	6×10^{-3}	- 17
West of 200 West Area	2×10^{-3}	3×10^{-3}	- 5
Prosser Barricade	1×10^{-3}	3×10^{-3}	- 2
100-B Area	1×10^{-3}	2×10^{-3}	-
Four miles SW of Redox	8×10^{-4}	1×10^{-3}	- 4
Three miles S of White Bluffs	2×10^{-3}	2×10^{-3}	- *
Route 4S, mile 14	9×10^{-4}	2×10^{-3}	- 9*
Wahluke Slope, E.	5×10^{-4}	8×10^{-4}	- 16*
Wahluke Slope, NE	4×10^{-4}	5×10^{-4}	- 8*

*The last four trend factors compare values with January rather than February because corresponding collections are made bimonthly.

Present values are approximately twice those of one year ago.

Fallout debris, presumably of off-Plant origin, was present in rabbit tissues in the following concentrations:

Sample Type	μc FP's/g sample Average	Trend Factor
Bone	1×10^{-4}	+ 3
Feces	3×10^{-5}	- 2
Liver	7×10^{-6}	-

Full-term fetuses of rabbits contained essentially the same concentrations of radioisotopes as adult animals.

Swamp Contamination

The following concentrations of fission products were found in tissues of waterfowl at the 221-U swamp:

Sample Type	μc FP's/g tissue Average	Maximum	Trend Factor
Coots			
Bone	5×10^{-4}	6×10^{-4}	- 2
Soft tissue	1×10^{-3}	1×10^{-3}	-
Diving ducks			
Bone	1×10^{-3}	1×10^{-3}	-
Soft tissue	8×10^{-4}	1×10^{-3}	-
Puddle ducks			
Bone	2×10^{-3}	4×10^{-3}	-
Soft tissue	5×10^{-4}	1×10^{-3}	-

These values are approximately twice those of 1956.

Columbia River Contamination

The contamination levels for beta emitters in representative aquatic forms and in waterfowl for March are shown in the following table. With the exception of plankton, virtually all of the activity reported is from P^{32}.

Sample Type	Collection Site	μc beta emitters/g tissue Average	Maximum	Trend Factor
Plankton	Hanford	8×10^{-2}	1×10^{-1}	-
Caddis larvae	"	5×10^{-3}	6×10^{-3}	-
Minnows	"	4×10^{-4}	7×10^{-4}	-
Whitefish (could not be caught because of muddy water)				
Puddle ducks *	Hanford	6×10^{-3}	2×10^{-2}	+ 12
Diving ducks *	"	3×10^{-3}	1×10^{-2}	-
Gulls *	"	7×10^{-5}	1×10^{-4}	-
Mergansers *	"	7×10^{-5}	1×10^{-4}	-

* Values are for flesh. Concentrations in bone are about three times higher for fish and three times higher for waterfowl.

The concentration of beta emitters in aquatic organisms is virtually unchanged from last month. Because of low temperature the level in fish is probably at a minimum for the year, but plankton is at near maximum because of the low flow. The values are approximately double of those of one year ago.

Effects of Reactor Effluent on Aquatic Organisms

Monitoring of effluent from the 105 KE reactor was interrupted early in the month when the young salmon were killed by toxic materials which entered the river water supply. Further tests at this site have been suspended until the control water system can be improved.

Monitoring of effluent from the 105-F reactor with yearling whitefish was terminated at the end of the month when this reactor was shut down for an extended period. This test showed that the mortality rate for young whitefish was significantly increased in two per cent strength effluent during the warm season of the year, but when water temperatures were below 15 C, they could tolerate effluent in concentrations as high as eight per cent.

Mortalities of juvenile whitefish held in temperatures 2 C and 3 C above average for the Columbia River are virtually unchanged from last month. Survival is best at the lowest temperature.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM AND TOXICITY OF RADIOACTIVE MATERIALS

Reactor Effluent

P^{32} administered by stomach tube to five four-month-old rats was absorbed and deposited in the skeleton to the extent of 11 per cent. This compares with an absorption and deposition in year-old rats of 4.7 per cent and strongly suggests that the approximately 2 per cent absorption and deposition observed in the year and one-half old rats on the chronic reactor effluent regimen was due largely, if not entirely, to an effect of age.

Plutonium

Urine from rats sacrificed 30 minutes after intravenous injection of Pu (IV) citrate was studied by paper electrophoresis techniques. Several discrete peaks of radioactivity were separated and seemed to correspond with regions of serum protein concentration shown on simultaneously electrophorized serum samples from the same animals. The urine radioactivity peaks, however, did not correspond to regions which stained for protein. The possibility that plutonium is present in both serum and urine in combinations other than with protein is being studied.

In rats sacrificed five weeks following intravenous Pu (IV) citrate administration, moderate concentrations of plutonium were detected in the cells and ducts of the submaxillary glands, suggesting that salivary secretion of plutonium is occurring in these animals.

Experiments are in progress to determine the effect of combinated zirconium citrate and EDTA administration on the removal of firmly deposited plutonium. The dose regimen seems to be well tolerated. No analytical results are as yet available.

Experiments were performed to compare the therapeutic effects of zirconium citrate administered simultaneously with calcium gluconate and mixed with calcium gluconate prior to administration. The zirconium citrate appeared to be better tolerated when mixed with the calcium gluconate. Animals were sacrificed after 48 hours but analytical data are not available.

Preliminary studies were made with Chel 185, Chel 330, and Chel 242P (Commercial chelating agents related to EDTA). These agents appeared to be well tolerated by the rats. No data are yet available on their effectiveness in plutonium removal.

By 72 hours after intratracheal administration of Pu(IV) nitrate in sodium citrate solution in miniature pigs, peak concentrations were obtained in both urine and feces. During these first four days a maximum of 0.35 per cent of the administered dose had appeared in the urine and 94 per cent in the feces.

Ruthenium

Simultaneous experiments were performed involving the administration by stomach tube of .01 N and 0.3 N, HCl solutions of Ru^{106} to three day, 189 day, and 365 day-old rats. There was no marked effect of either acidity or age on total absorption and retention at 24 hours. Kidney deposition appeared to be significantly higher in the older animals. Total ruthenium absorbed and retained at 24 hours amounted to 2 to 5 per cent, which is about three times higher than observed in earlier experiments. No explanation for the increased absorption and lack of effect of age observed in this experiment is immediately apparent.

Iodine

All groups of swine fed 0.5, 5.0 and 45.0 μc/day show a steady seasonal decline in thyroid avidity for I^{131}. There is yet no evidence of thyroid damage in the swine fed 45 μc/day even though the estimated thyroid dose exceeds 8,000 rads.

An additional three animals were fed 100 μc each in a short-term study designed to determine the contribution of short-lived iodine isotopes to thyroid dosage and also to determine the I^{131} half-life in blood. Within fifteen minutes following I^{131} administration, 2.5 to 3 per cent of dose was in the thyroid, and blood concentration values were about 0.009 μc/ml. Peak blood values were attained at 4½ to 6 hours and the effective half-life in the blood was 3½ to 5 days. Peak thyroid values were obtained at 48 hours and the effective thyroidal I^{131} half-life was 5½ to 6 days.

Zn^{65} Study in a Steer

In support of work performed in the Department of Biochemistry, School of Medicine, University of Washington, a steer, provided by the State College of

Washington, bearing an exteriorized pancreatic duct cannula, was injected with Zn^{65}.

A total of 26 mc was administered intravenously via an indwelling catheter over a period of 10 days. During this period the entire output of the pancreas, about 7 liters, was collected. This was made possible by replacement therapy, evolved locally, which included daily feeding of 25 grams of pancreatin and a continuous drip into the intestinal catheter of an aminosol (Abbott) solution.

Radioactive Particles

The previously reported pulmonary retention of approximately 12 per cent of inhaled $Ru^{106}O_2$ immediately after exposure has been verified in additional experiments. This value was assumed for insoluble particles by the International Commission on Radiological Protection. The fraction present in the stomach and intestines at the end of the exposure period varied with the duration of the exposure from 10 per cent to 60 per cent.

Mice exposed for 15 minutes to $Ru^{106}O_2$ dust were sacrificed at times up to five hours. The fraction of inhaled Ru^{106} present in the lung decreased from 12 per cent immediately after exposure to 4 per cent after two hours then increased to 8 per cent after five hours. These fluctuations in lung deposition of inhaled $Ru^{106}O_2$ were also apparent in individual mice periodically scanned with a gamma scintillation counter.

Lobal distribution within the lungs following inhalation of $Ru^{106}O_2$ dust did not vary significantly from that administered by intratracheal injection.

An invasive malignant lung tumor was found in a mouse 349 days after intratracheal administration of 4.5 μc $Ru^{106}O_2$. This is the first malignant tumor observed in mice treated with $Ru^{106}O_2$ and differs histologically from that observed in mice after exposure to plutonium oxide.

Enclosure of an aerosol exposure chamber for mice in an improved glove box is complete. $Ru^{106}O_2$ particles have been prepared for initiation of mouse inhalation exposures for the study of long-term turnover and tissue distribution.

A one-way valve and a preliminary model of a plastic mask for exposing dogs to aerosols have been fabricated.

Gastrointestinal Radiation Injury

Additional rats were exposed to intestinal irradiation by X-ray and by Y^{91} feeding, and subsequently injected with Fe^{59} to determine the effect of irradiation on uptake of iron by the red cells. In all cases a delayed effect amounting to a 30 to 40 per cent reduction in iron uptake was observed from 3 to 6 days after the irradiation, during the period in which maximum damage to the intestinal tract is apparent histologically. This effect, therefore, appears not to be a direct effect of irradiation of blood cells but an indirect effect possibly due to loss of blood through hemorrhaging into the intestines or to toxic products resulting from the intestinal damage.

Relative Biological Effectiveness

Additional experiments comparing RBE values obtained from viability data with those obtained from mutation studies showed considerably more variability than those previously reported. While one test using S^{35} gave a genetic RBE five times that obtained from viability data, another using tritium showed no difference in RBE values. The extreme variability indicates that both better methods need to be developed and more data need to be accumulated.

The effect of anaerobic and aerobic growing conditions on the radiation sensitivity of yeast was tested using tritium as the radiation source. Tritium was only 1/3 to 1/2 as effective in reducing viability under anaerobic as under aerobic conditions.

The previous observation was substantiated that haploid yeast grown in standard medium and S^{35} accumulates a relatively higher concentration of S^{35} than is present in the medium. Increasing the sulfate concentration 20-fold does away with the unequal distribution of S^{35} between cells and medium and should thus allow a more precise evaluation of dose and RBE.

Genetic Effects of Metabolized Isotopes

Haploid yeast cells were grown on an agar slant containing S^{35} and subsequently dried in a vacuum desiccator. Similar cells grown in the absence of S^{35} were treated with a colloidal form of S^{35} and subsequently lyophilized. Concentrations of S^{35} were determined for cells grown under the two conditions and found to be approximately equal. These cells are being stored to allow radioactive decay in transmutation studies.

Uptake of Radioactive Substances by Growing Plants

It was previously reported that chloride ion did not stimulate the uptake of I^{131} as had been observed when iodide ion was present in the root environment. Similar tests with bromide ion showed an approximately twofold increase of uptake of I^{131} but still no effect to compare with that observed with iodide.

Studies on the toxicity of dichromate failed to show effects at as low levels as were previously reported. No decrease in yield was observed using the Neubauer technique, with concentrations of dichromate as high as 60 μg/g of soil. Greenhouse studies suggested that the amount of aeration was of considerable consequence to the observation of toxic effects. Lack of proper aeration in the root environment seemed to markedly enhance the toxic effects of dichromate.

The effect of calcium and strontium carrier on the uptake of Ca^{45} and Sr^{89} was evaluated in a preliminary experiment. The uptake of strontium-89 was

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stimulated equally by the addition of calcium and strontium carrier up to concentrations of 1,000 µg/g of soil. Likewise, the uptake of Ca^{45} was equally stimulated by the two types of carrier. There was a strong suggestion that Sr^{89} was preferentially absorbed over Ca^{45}.

HA Kornberg

Manager
BIOLOGY OPERATION

HA Kornberg:es

[redacted]

C. Offsite Visits and HLO Visitors

Name	Dates	Company Represented or Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
(Visits to Hanford Works)						
Robert Gurnell and Albert Hanson	3/21/57	AEC, Washington, DC	Tour Biology facilities	HA Kornberg DE Warner RF Foster LK Bustad	No	100-F - 108-F, 141-M 146-FR
Henry A. Burd A.W. Fairhall W.T. Edmondson W. Moulton E.M. Conrad Austin Eastman Lloyd W. Schram Neil O. Hines	3/25/57	Univ. of Washington, Seattle	Tour Biology facilities	HA Kornberg and staff	No	100-F - 108½F, 141-M 146-FR
(Visits to other Installations)						
J. F. Cline	3/3/57	Methodist Church, Walla Walla, Washington	Present a talk on "Peaceful Uses of Atomic Energy in Agriculture"	-	No	

D. Lectures

a. Papers presented at meetings

J. F. Cline, March 3, 1957 - "Peaceful Uses of Atomic Energy in Agriculture," - Methodist Church, Walla Walla, Washington.

b. Seminars

Dr. L. K. Bustad, March 26, 1957 - "Radiation Tumorigenesis I. General Discussion"

Dr. S. Marks, March 26, 1957 - "Radiation Tumorigenesis II. Thyroid Tumors"

E. Publications

Open Literature

Barnes, C.M., S. Marks, D.E. Warner, and L.K. Bustad, "Thyroid Function in Fetal Sheep," Endocrinology 60, 325 (1957).

Marks, S., N.L. Dockum, and L.K. Bustad, "Histopathology of the Thyroid Gland of Sheep in Prolonged Daily Administration of I^{131}," Am. J. of Path. 33, 219 (March-April 1957).

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OPERATIONS RESEARCH AND SYNTHESIS OPERATION
MONTHLY REPORT

March, 1957

ORGANIZATION AND PERSONNEL

P. E. Leaverton was transferred from the Rotational Training Program to a direct assignment in the Operations Research & Synthesis Operation on March 18, 1957.

OPERATIONS RESEARCH ACTIVITIES

Economic Studies

Several discussions were held with personnel from the operating departments to review the recent meeting of the Combined Operations Working Committee.

The study of appropriate HAPO motivations in line with AEC objectives was continued.

Personnel Data

As reported last month, a system that may be useful in dealing with the problem of matching, in some optimum fashion, the qualifications of an individual with plant-wide opportunities available has been formulated. During the month, discussions were held with Employee Relations managers throughout the HAPO to acquaint them with this system and concepts on which it is based. At their request, forms for testing the practicality of the system were made up for detailed consideration. A report on the progress to date in this area will be ready early in April.

Investigation of Problem Areas

A scoping report on measurements which was to have been completed during March is in rough draft form and will be issued early in April.

Consideration is being given to the reactivation of the study of cost accounting by matrix methods which had been placed in a stand-by status.

STATISTICAL AND MATHEMATICAL ACTIVITIES IN SUPPORT OF RESEARCH PROGRAMS

2000 Program - Metallurgy

Complete solutions to two linear, non-homogeneous partial differential equations which describe the space-time configuration of the heat release in a gas-solid catalytic reactor were obtained for a member of Heavy Element Chemistry, Chemical Research Operation.

A diffusion experiment, involving the penetration of uranium into aluminum alloy M-388 and vice-versa in bonded couples, is being conducted by personnel of the Physical Metallurgy Operation. This is similar to the recently completed experiment in which alsi and uranium were considered. Penetration data from one couple have thus far been submitted for analysis, and from these, an estimated maximum penetration for the couple was found.

The Plutonium Metallurgy Operation has requested statistical assistance to determine whether Al-Pu cast rods contemplated as PTCR test fuel meet plutonium content and uniformity specifications. Data are currently being analyzed.

Least square regression planes to estimate the functional relationship between specific gravity, uranium (in molar units) and nitric acid (in molar units) in dissolver solutions were fitted for the Chemical Research Operation. The regression equations were sent to W. W. Mills in an unclassified letter, "Least Square Estimation," dated March 12, 1957.

2000 Program - Reactor

A table to facilitate construction of confidence interval estimates of K_{oo}, the coefficient of fast neutron multiplication, was computed for Lattice Physics.

6000 Program - Biology and Medicine

Analysis continued in March of the fixed vs. variable dose experiment described in the February report. Sample-dilute-count data analysis was also continued.

Pharmacology Operation recently installed an aerosol chamber to investigate experimentally deposition of air-borne radioactive particles in mouse respiratory tract organs. Data from instrument calibration experiments were analyzed to determine the effect of within chamber position on deposition. Results of the analysis and recommendations for future experimental procedure were sent to W. J. Bair in an unclassified letter, "Statistical Analysis - Deposition of $RU^{106}O_2$ as a Function of Chamber Position," dated March 11, 1957.

A statistical analysis was made of data from an experiment concerned with determining the effect of Separan on rainbow trout. (Separan in detectable amounts is present in effluent water.) Results were sent to P. A. Olson in an unclassified letter, "Statistical Analysis - Effect of Separan on Rainbow Trout," dated March 22, 1957.

Statistical evaluation was made of data from a Biology Operation experiment to determine the increased toxic effect on aquatic life resulting from direct to river flow of effluent water without the present five hour decay period in retention basins. The results of the study were sent to R. C. Pendleton in an unclassified letter, "Analysis of K. E. Retention Time Study Data," on March 22, 1957.

Computations of modified gamma integrals were done in connection with stable atmosphere plume distribution theory, and the results were sent in rough draft form to G. R. Hilst of the Atmospheric Physics Operation.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR THE PRODUCT DEPARTMENTS

Fuels Preparation Department

In connection with the program for determining acceptance criteria for shipments of C slugs based on test pile reactivity results, data obtained on a recent shipment which contained fuel elements of only one enrichment level were submitted for statistical analysis. A final evaluation of the feasibility of this approach depends on the correlation between test pile results and true enrichment levels. This is presently being considered.

Data submitted by personnel from the Materials Engineering Operation are being analyzed to determine whether ingot type, rod number, and slug location have an effect on any of several yield variables. In particular, sonic orientation values have been calculated and the data punched on IBM cards in preparation for future analyses.

Sonic orientation values for different delay quench periods were analyzed in order to compare the effect of different delay times.

Consultation services were provided to personnel of the Materials Engineering Operation in connection with the number of tubes necessary to determine statistically significant changes in stability characteristics.

A comparison was made between reject rates for different density specifications as a function of the carbon content in the ingots. A negative correlation between density and carbon content indicated a substantial increase in the rejection rate would result from a proposed high specification for density, particularly for ingots in the high carbon range. Results were reported in an unclassified letter to R. E. Olson, 3-12-57, "Some Effects of Changing Density Specifications on Incoming Rods."

Cans fabricated from various types of alloy were tested to determine any difference in residual can wall thickness. The data from this test were analyzed and the results given to Quality Audit personnel.

An analysis to determine the measurement efficiency of the penetration tester with respect to residual can wall thickness was made at the request of Fuels Preparation personnel. Results of this analysis have provided Quality Audit personnel with a guide as to what standards should be required. Additional tests are being made.

Data from an experiment to determine the effect of silicon addition to the canning and duplex baths on Poor Bond and Bond Test rejects are being analyzed.

Canning yields for I and E slugs were submitted for analysis by the "Learning Curve" technique. It is desired to estimate the future quality and yield of I and E slugs.

Orientation sessions covering various pertinent statistical topics are given weekly to various personnel of the Fuels Preparation Department. At the request of the Supervisor, Quality Audit, a talk was given outlining the functions of the Industrial Statistics group and presenting some methods of analyzing data. Considerable enthusiasm was evidenced for this subject and, as a result, a second talk was given as requested.

The weight of I and E slugs is a function, among other things, of the inner diameter. The effect of relaxing specifications for the variance of the inner diameter of virgin slugs on the percentage of second recovery slugs which fall below present weight specifications was studied, and the results were submitted to personnel of the Process Engineering Operation. A chart giving lower tolerance limit on weights of second recovery slugs as a function of the increase in virgin slug inner diameter variance was also submitted.

Salary Administration personnel were concerned with obtaining information as to the extent to which salary information has been given to exempt employees. Recommended sample sizes for a proposed survey were furnished.

A study of absenteeism rates in the Maintainence and Power Operation was requested. Expected monthly rates based on past HAPO rates were found, and these results, along with comments on the feasibility of further study and data collection, were submitted to W. A. Shanks.

Irradiation Processing Department

With respect to the use of approximate 1956 exposure figures as opposed to Production Scheduling figures in the analysis of rupture data, a table of bias correction factors was calculated which will correct these approximate figures in those month-area combinations where such biases were appreciable. These were reported in an unclassified letter to R. R. Bloomstrand, 2-28-57, "Exposure Correction Factors for 1956 Data."

Process Analysis Operation personnel have collected and submitted for analysis considerable rupture data in which the distribution of exposures at discharge are listed for each of three types of fuel elements -- K, M, and Z. A further classification into different power groups within each fuel element type was given. The data are presently being analyzed, primarily in order to compare the K and M fuel elements.

The effect of the distance from control rod banks on the type of rupture was investigated, using data from the C Reactor compiled by Process Analysis Operation personnel. For tubes classified into four categories as determined by their distance from the rod banks, the numbers of split and hot-spot ruptures

were given. A statistical test was made which compared the proportions of splits to hot-spot ruptures within each category. The results were reported in a confidential undocumented letter to R. R. Bloomstrand, dated 3-22-57, "Type of Rupture vs. Proximity to Rod Bank."

Further work is being done on the problem of adjusting reactor operating conditions on the basis of past rupture data to attain optimum production. Research and Engineering Operation personnel have requested that the various alternatives for action be evaluated from the statistical risk viewpoint. Such risk statements will be helpful to the area engineers as they routinely recommend adjustments in reactor powers.

As previously reported, an investigation of past data was being made in order to firm up or adjust the slope parameter value of 7.6 which had been used in the analysis of run-to-rupture test data. Based on the results of this investigation, recommendations to adjust this value have been made. (HW-48997, 3-12-57, "Recommended Changes in the Slope Parameter Value for Analysis of Run-to-Rupture Tests.")

In the original development of the run-to-rupture test, exposures were calculated on an MWD/Ton basis. As long as the fuel elements being compared had the same weight, it made no difference whether exposure were reported as MWD/Ton or MWD/Tube. However, now that different geometries, and hence different weights, are being compared, the method of reporting exposures becomes important. This general problem was discussed in a secret rough draft to W. K. Kratzer. (HW-49174 RD, 3-21-57, "Analysis of Run-to-Rupture Tests using MWD/Tube as Opposed to MWD/Ton.")

Based on data from four tubes of 3/8" cored fuel elements from KE reactor, an estimate of the proportion of tubes charged with such metal which will be expected to have one or more fuel elements with effective warp greater than the K reactor annulus of 120 mils was found. This was done in order to determine the possibility of an extensive stuck charge problem for these fuel elements. Results were reported in a confidential undocumented letter to W. K Kratzer, 3-20-57, "Effective Warp of 3/8" Cored Fuel Elements at KE."

Further discussions were held with Industrial Engineering Operation personnel concerning estimation problems arising in the work sampling study currently being conducted in the K area.

Mathematical consultation was provided to the Maintenance Engineers, 100-F area, on the problem of calibrating a horizontal cylindrical tank with spherical segments ends.

Chemical Processing Department

Due to the inherent difficulties in obtaining good estimates of population parameters from small samples obtained from small populations, the problem of conformance with current population tolerance specifications on fabricated plutonium parts during special production periods is being considered in conjunction with other HAPO personnel and personnel from LASL.

An analysis of variance of the data obtained in the 234-5 control laboratory in the daily volumetric determination of the plutonium content of two plutonium standards showed a significant difference between the three equipment-analyst combinations and a lack of agreement between iron and plutonium standards. Consequently, the ceric normality used in calculating the plutonium content of fabricated parts was changed. Rather than using the average of two iron standards each day by each analyst, the average of the twelve titrations obtained on 2 successive days will be used.

The use of an average efficiency for the conversion of UO_3 to UF_4, in the measurement of UO_3 reactivity ratio in the 222-S Laboratory, rather than measurement of the apparatus efficiency by means of two standards each time the apparatus is used was recommended in a letter to J. W. Jordan. Analysis of the data also indicated that the volumetric determination of the fluoride content of the UF_4 is the major source of analytical variation.

At the request of personnel of the Finished Products Technology Operation, a study is being made to determine an estimate of the uncertainty in the monthly estimate of the weight of depleted uranium received from Redox, Purex, and TBP.

OTHER STATISTICAL AND MATHEMATICAL ACTIVITES

A meeting was held with personnel of the SS Measurements Operation regarding a review of the 200 areas measurement precisions and accuracies. They have prepared an outline of the measurement characteristics, and a plan has been adopted as to the order in which the different measurements will be studied.

Discussions were held with interested personnel of Financial Operation concerning the feasibility of employing a sample inventory plan to estimate the General Stores' stock. Such a procedure would replace the current one that entails a yearly complete physical inventory of Stores. Mathematical evaluation of possible sample plans is necessary before final recommendations can be made.

Probability models to explain the random behavior of cascade emission involved in radioactive decay were derived for personnel of the Chemical Instrumentation Operation. The models are to be used to compare the gamma photon counting efficiencies of several experimental procedures.

Precision and accuracy analyses were performed on routine data submitted by General Chemical Analysis Operation. The results were reported orally to F. E. Holt.

Evaluation of the film strip density readings calibration method currently being used by Radiation Protection Operation was initiated in March. Statistical analysis of calibration data for January and February has started. Discussions concerning possible modifications of the present calibration were also held with interested personnel.

Discussions were held with personnel of Technical Information Operation concerning the format of a questionnaire designed to provide information on the usefulness, completeness and efficiency of the Plant Library's services to HAPO. Recommendations as to how the questionnaire could be condensed, made more functional and less ambiguous were given orally to interested persons.

The variance of the standard deviation from a finite population when a considerable proportion of the population is sampled is of practical importance and is inadequately treated in the literature. To study this problem the 650 computer is being programmed to take random samples from a finite population of values, which in turn were taken from a table of random normal deviates, calculate the standard deviation, and make a frequency distributions of the resulting standard deviations.

The many requests for one-sided tolerance limits prompted the preparation of a set of tables for various sample sizes N, population proportions P, and confidence levels γ . The programming has been completed and the tables are being prepared.

In order to acquaint production department supervision with the existence of the Industrial Statistics group, and of the many types of problems amenable to a statistical analysis, a series of newsletters dealing with statistical topics are being planned for distribution. Pre-printed master duplimats are now being prepared, and the first newsletter will be issued soon.

4. A short report on progress to date was given to the HLO Research staff meeting on March 21.

5. Reports received from the three product departments and V. D. Donihee during the month were reviewed, and work is underway to define existing gaps and prepare a uniform description of the Hanford system.

OFFSITE VISITS AND VISITORS

W. L. Nicholson visited Washington State College at Pullman, Washington and the University of Idaho, Moscow, Idaho on March 11 as a representative of the School of Nuclear Engineering.

C. A. Bennett was the speaker at regular monthly meetings of three Texas sections of the American Society for Quality Control on March 13, 14 and 15, and participated in a symposium on statistical quality control at Southern Methodist University on March 16.

Carl A. Bennett

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

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RADIATION PROTECTION OPERATION MONTHLY REPORT - MARCH, 1957

A. ORGANIZATION AND PERSONNEL

Organization

No significant changes in organization occurred.

Force Summary	2-28-57	3-31-57
Exempt	41	41
Nonexempt	204	201
Total	245	242

B. ACTIVITIES

Radiation Monitoring

Work continued on the Minor Construction project CG-558 on the new 105-107-F effluent line. A maximum dose rate of 1 r/hour was measured on the existing line. Dose rates of 5.9 rads/hour including 0.7 r/hour were encountered during Minor Construction work on the Redox contamination control project. The maximum dose rate to personnel was 500 mr/hour while covering cracks and seams in the craneway with lead sheet and sealer.

Excessive dose rates to personnel were associated with work at the Hot Semi-Works, the 3706 Building and Biology. At the Hot Semi-Works dose rates of 100 rads/hour caused personnel to work in locations up to 3 rads/hour to the hands and 1 rad/hour to the body. Analysis of HAPO-184 samples in 3706 caused hand exposure to dose rates up to 10 r/hour. Injection of Zn^{65} into a steer caused momentary dose rates from a lead-lined syringe of 60 r/hour. The animal itself emitted a dose rate of 70 mr/hour through its hide.

Progress was made on the 300 Area and HLO emergency procedures. Radiological defense supplies were consolidated in the 3745 Building. Upon request of the AEC, a composite Hanford Laboratories budget for Civil Defense was prepared and submitted.

Regional Monitoring

The average beta-emitter activity density in drinking water at 100-D, 100-DR and 100-F was about 1×10^{-5} μc/ml, which represents about 0.5% of the maximum permissible concentration recommended by the National Committee on Radiation Protection and Measurement (NCRP). The activity density in the river water in the Pasco and Kennewick areas was about 3×10^{-6} μc β/ml, which represents about 4% of the maximum permissible concentration recommended by the NCRP. Isotopic analyses of raw and sanitary water samples at Pasco indicated P^{32} and As^{76} are more efficiently removed (total factor of 10 reduction) by the Pasco and 183-F area water plants than by the Kennewick system. Na^{24}, Cr^{51} and Np^{239} are not removed significantly by any of the water treatment plants.

The average daily emission of I^{131} was 1.1 curies compared to 1.7 curies in February. The maximum total emission in any seven-day period was 16 curies; primarily from Redox. The average deposition of I^{131} on vegetation outside the plant perimeter

did not exceed the maximum permissible limit of 1 x 10^{-5} μc/gm although individual samples ranged from 0.3 to 3.5 x 10^{-5} μc/gm. A revision in laboratory analyses caused a factor of three increase in the I^{131} values on vegetation as reported by the Radiochemical Analyses Laboratory. Some indication of other-than-Hanford radioactive deposition on vegetation was observed on March 16 and 17.

Wells drilled around the Purex A-8 crib and those down-gradient westward continued to increase in beta-emitter activity to a current activity density of about 2 x 10^{-3} μc/ml near the point of disposal.

Exposure Evaluation and Records

Two cases of plutonium deposition were confirmed during the month. Neither case involved significant deposition. The total number of cases on record to date is 200.

No radiation incidents involving exposure above permissible limits were reported. One incident, involving facial contamination and potential inhalation of plutonium by a CPD maintenance employee, appeared to be of minor consequence from analysis of first bioassay samples. The employee was administered zirconium citrate as a precautionary measure.

Microfilming of the posted Bioassay records and the 1955 personnel exposure folders was completed. Auditing and updating was completed on the IBM tape carrying 1956 film badge records on all General Electric and government employees at Hanford. Conversion to the new plastic badge was completed in 200 East Area and 100-F Area. Total cash credit at month's end from recovered silver from the old badges was about $14,000.

Improved film badge trays were received from the manufacturer and placed into service. The new tray, which was designed by Radiological Development relieved a bottleneck in the darkroom by an increase in the batch size of film being processed.

Calibrations

Business was normal in Calibrations. Assistance was provided to Radiological Development in exposing a new type of dosimeter film to various doses and photon energies and making shielding studies of several types of eye goggles.

Further action on modification of the new vertical track and trolley in the second calibration well was postponed due to curtailment of expenditures.

An order for 18 scintillation poppy probes was placed with Eberline Instrument Division at a unit cost of $122.74. An order was placed with the Chromium Corporation of America for samples of nickel foils of 1, 3, 5 and 10 microns thick. Hopes are that these will be superior light shields for scintillation portable poppies.

A new beta calibration jig was placed into service for calibrating GM meters. This will eliminate the use of a radium source and permit more rapid calibration of GM meters.

Radiological Development

Interest in the new plastic film badge continued from other AEC sites. Information was transmitted as requested. An abstract was prepared for submission to a technical

journal. Derivation of methods of evaluating mixed energy gamma dose continued. A new type of film, Eastman Kodak personnel monitoring film type II, was exposed to varying doses for evaluation. The objective is to increase sensitivity. Active programming for data processing of the balance of personnel records was deferred until FY 1958 for lack of available funds.

Bids were received and an order placed for 20 prototype plastic bioassay flask containers. The full scale order now appears to be in the $10 - $15 unit cost range in quantities of 1,000.

At the request of Industrial Medicine a brief study was undertaken to measure the dose to the gonads during chest X-rays.

Radiological Consultation

Calculations of the zinc-65 uptake in pancreatic juices were made for the Biology Operation. These calculations were designed to indicate the relationships between the concentration of zinc-65 on chronic and acute administration. A review of a document on the effects of thorotrast administration was made. The main comments were on the need to indicate the validity of the sample chosen and the need to indicate that thorotrast may not be representative of thorium taken into the body by industrial exposures.

The recent ruptures of cored fuel elements and the consequent release of the noble fission gases around operating reactors has emphasized the radiological problems with these gases. A review of the information available on the hazard of such gases was started to serve as a guide to the Radiation Monitoring Operations in the 100 Areas.

Internal Exposure Studies

The MPC for Neptunium-239 in drinking water was evaluated taking into account the build-up of plutonium resulting from the disintegration of Np^{239} in the body. Recommended values from this study were 1 μc/cc based on the dose to the bone and 2×10^{-3} μc/cc based on dose to the GI tract.

Columbia River Studies

A review of the information available on the effects of discharge of reactor effluent water along the shore of the river was made. Although no clear-cut evidence on this case is available, it appeared that a shoreline discharge at 100-K would increase the concentration of radioactive materials in the 100-D intake by at least a factor of eight over the present concentration. Such an increase would lead to sizeable radiation dosage rates on the dry filter beds and would increase the internal radiation problem in the 100 Areas.

An advance toward routine monthly evaluation by Regional Monitoring of environmental radiation exposures was publication of a detailed method for calculating potential exposure from drinking Columbia River water. From a recent careful analysis of the rare earth plus yttrium group in reactor effluent water (HW-48021), a decay curve for reading concentrations downstream was drawn, and an MPC for the mixture in the 15 to 30 hour decay range was calculated. This was included in a listing of MPC's to match the radioisotopes and mixtures measured in fresh effluent from each reactor,

which are averaged against power levels, calculated for decay to Parco, and documented for each month by Radiological Chemical Analysis Operation. New MPC's for several isotopes and groups had to be calculated to complete the list. By the published method, potential exposure from drinking the radioisotopes from reactor effluent in river or sanitary water at any location can be computed.

Radiological Standards

Drafting of the Basic Radiation Protection standard on permissible limits neared completion. Application was made of the recent NCRP reductions in permissible limits.

A listing of the latest maximum permissible body burdens and concentrations in air and water for about 250 radioisotopes was prepared for publication. This will be issued soon as an appendix in the Manual of Radiation Protection Standards. New biological factors determined by HLO Biology Operation for tritium and ruthenium were included for application to Hanford.

The chapters on occupational and nonoccupational exposure limits in the second draft of the revision of NBC Handbook 42 for the NCRP are being rewritten, incorporating the recent recommendations. New data for the chapter on shielding are being obtained from offsite.

Compilation of information requested of a local member of the ASA Z-54 Subcommittee on Permissible Contamination Levels of Industrial Materials was initiated and nearly completed.

C. EMPLOYEE RELATIONS

Safety

Two medical treatment injury occurred for an injury frequency of 0.5.

Security

No security violations occurred.

Suggestions

Radiation Protection personnel submitted seven suggestions in March. Three employees were awarded a total of $100. Sixteen suggestions were evaluated during the month.

Grievances

No grievances were received in March.

Beneficial Moves

Two beneficial moves occurred including the promotion of E. R. Wood to Badge Supervisor.

Extra-Company Contacts

J. W. Healy formally accepted membership on Subcommittee II on Permissible Internal Dose of the National Committee on Radiation Protection. J. W. Healy also accepted nomination for President-Elect of the Health Physics Society.

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 Visited
John Pingel Ken Okolowitz	3/18-20/57	Argonne National Lab. Lemont, Illinois	Discuss stack monitoring, plastic badges and IBM computing procedures.	JK Soldat BV Andersen LF Kocher CM Unruh HA Meloeny	No	300:329, 3706 3705
Maurice Griffel W. P. Haaff R. L. Klingensmith J. D. McAdo	3/4/57	Westinghouse Corp.	Discuss environmental hazards from the release of radioactive effluents to the atmosphere.	JW Healy HV Clukey	No	300:3746
Lt. C. L. Hall	3/6/57	Washington State Patrol, Olympia, Washington	Attain information to train patrolmen for radiological disasters.	JW Healy BG Lindberg	No	300:3746
John Rupley Dr. T. W. Penfold	3/13-17/57	U. of Washington, National Science Foundation	Plan experiment of injection of Zn^{65} to a steer.	RL Pierce JM Barton HJ Paas	No	100-F: 141-F

VISITS TO OTHER INSTALLATIONS

J. W. Vanderbeek	3/7-8/57	General Electric Cincinnati, Ohio	Attend GE conference on radiation protection.	JJ Fitzgerald	No	
J. W. Healy	3/14-16/57	National Reactor Testing Station, Idaho Falls, Idaho	Witness experiments of interest in connection with reactor accidents.	Dr. V. Beard	Yes	
R. G. Clark	3/22/57	Washington Asso. of Chiefs of Police Wenatchee, Washington	Deliver lecture at quarterly meetings.	----	No	

REGIONAL MONITORING

The general findings are summarized in the following:

Sample Type and Location	Activity Type	Average Activity Density μc/ml	Trend* Factor
Drinking Water and Related Materials			
Benton City Water Co. Well	alpha	9.1×10^{-9}	--
Richland Wells	alpha	$<5 \times 10^{-9}$	--
100 Areas	beta	$(0.008 \text{ to } 1.0) \times 10^{-5}$	--
200 Areas	beta	$(0.5 \text{ to } 1.0) \times 10^{-7}$	--
Pasco, Kennewick, McNary Dam	beta	$(<0.05 \text{ to } 2.8) \times 10^{-6}$	-2
Backwash Solids - Pasco Filter Plant	beta	6.9×10^{-2} μc/gm	-3
Backwash Liquids - Pasco Filter Plant	beta	2.6×10^{-5}	+7
Anthracite, Sand Filter - Pasco Filter Plant	beta	1.7×10^{-4} μc/gm	-2
Other Waters and Related Materials			
200 West Wells	beta	$<2 \times 10^{-7}$ to 1.0×10^{-2}	--
200 East Wells	beta	$<2 \times 10^{-7}$ to 4.0×10^{-2}	--
Wells Near 200 Areas	beta	$<2 \times 10^{-7}$ to 6.3×10^{-7}	--
107 and 108 Wells	beta	$<2 \times 10^{-7}$ to 2.0×10^{-4}	-8
Outlying Wells	beta	$<2 \times 10^{-7}$	--
Columbia River - Hanford Ferry	beta	3.5×10^{-5}	--
Columbia River - Below Reactors	beta	3.2×10^{-5}	--
Columbia River - Paterson To McNary	beta	9.6×10^{-7}	--
Columbia River - Shore Mud	beta	$(0.2 \text{ to } 1.5) \times 10^{-4}$	-3
Raw Water - Operating Areas	beta	$(0.005 \text{ to } 2.8) \times 10^{-5}$	--
Reactor Effluent Retention Basins to River	beta	11,600 to 52,200 μc/sec/reactor	--
		$(4.8 \text{ to } 9.9) \times 10^{-3}$	--
Reactor Effluent Retention Basins to River	alpha	<0.04 μc/sec/reactor	--
		$<5 \times 10^{-9}$	--

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

Sample Type and Location	Activity Type	Average Activity Density μc/ml	Trend* Factor
Other Waters and Related Materials (contd)			
I-131 in Farm Wastes to River	I-131	1.6×10^{-6}	+2
I-131 in Columbia River - Hanford	I-131	1.1×10^{-7}	--
Atomospheric Pollution			
Gross Alpha Emitters	alpha	$(<0.4 \text{ to } 1.6) \times 10^{-14}$	--
Gross Dose Rate - Separations Areas	beta-gamma	1.7 to 2.8 mrad/day	-5
Gross Dose Rate - Residential Areas	beta-gamma	0.5 to 3.8 mrad/day	--
Active Particles - Separations Areas	beta	$(1.7 \text{ to } 6.1) \times 10^{-13}$	--
I-131 Separations Areas	I-131	$(1.1 \text{ to } 4.9) \times 10^{-13}$	--
I-131 Separations Stacks	I-131	1.1 curies/day	--
Ruthenium - Separations Stacks	Ru-103-106	<0.02 curie/day	--
Active Particles - Wash., Idaho, Ore., Mont.	--	0.002 to 0.038 ptle/m^3	--
Active Particles - Project	--	0.001 to 0.016 ptle/m^3	-2
Vegetation			
Environs of Separations Areas	I-131	$(<0.3 \text{ to } 5.2) \times 10^{-5}$ μc/gm	+3
Residential Areas	I-131	$(<0.3 \text{ to } 1.0) \times 10^{-5}$ μc/gm	+2
Eastern Washington and Oregon	I-131	$< 3 \times 10^{-6}$ μc/gm	--
Non-Volatile Beta Emitters Wash. and Ore.	beta	$(0.01 \text{ to } 1.2) \times 10^{-3}$ μc/gm	+4
Alpha Emitters - Separations Areas	alpha	$(0.3 \text{ to } 1.9) \times 10^{-6}$ μc/gm	--

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

RADIATION MONITORING	Hanford Laboratories	Construction Engineering	Others	March Total	1957 To Date
Special Work Permits	1,257	728	171	2,156	7,039
Radiation Surveys	1,467	1,008	268	2,743	8,004
Air Samples	1,977	88	78	2,143	6,356
Skin Contamination	13	11	0	24	60
*Class II Radiation Incidents	0	0	0	0	0
**Class II Radiation Incidents	0	0	0	0	0

EXPOSURE RECORDS

Gamma Pencils	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
March	251,542	12	17	10
1957 to Date	809,224	31	47	30

Beta-Gamma Film Badges

	Badges Processed	Readings 100-300 mrads	Readings 300-500 mrads	Readings Over 500 mrads	Lost Readings	Average Dose Per Film Packet mrad(ow)	mr(s)
March	49,426	656	13	6	75	2.22	3.00
1957 to Date	156,275	1,731	46	18	197	1.79	2.84

Slow Neutron Pencils

	Pencils Processed	Paired Readings 4-12 mrem	Paired Readings Over 12 mrem	Lost Readings
March	2,004	14	2	2
1957 to Date	6,852	65	18	4

Fast Neutron Film Badges

	Badges Processed	Readings Above 50 mrem	Lost Readings
March	1,015	0	1
1957 to Date	2,938	0	1

Bioassay

	March	1957 to Date
Plutonium: Samples Assayed	1,260	3,721
Results above 2.2×10^{-8} µc/sample	27	78
Fission Product: Samples Assayed	1,452	4,158
Results above 3.1×10^{-5} µc FP/sample	2	5
Uranium: Samples Assayed	392	1,202

*Radiation Monitoring Operation Customers
**Total Plant

[redacted]

Uranium Analyses	Following Exposure Units of 10^{-9} µc U/cc			Following Period of No Exposure Units of 10^{-9} µc U/cc		
Sample Description	Maximum	Average	Number Samples	Maximum	Average	Number Samples
Fuels Preparation	7.38	1.83	121	3.53	1.39	41
Hanford Laboratories	8.20	2.21	16	3.47	1.20	19
CPD - Finished Products Uranium Reduction	8.83	3.66	75	7.69	2.52	73
Special Incidents	6.56	3.47	6	--	--	--
Random	--	--	--	--	--	--

Tritium Analyses	March	1957 to Date
Samples Assayed	0	1
Thyroid Checks		
Checks Taken	0	127
Checks Indicating .01 µc	0	0
Hand Checks		
Checks Taken - alpha	49,307	160,386
- beta-gamma	48,871	152,305

CALIBRATIONS

Portable Instrument Calibration	Number of Units Calibrated March	1957 to Date
CP Meter	1,038	3,158
Juno	357	1,129
GM	1,351	4,204
Other	191	551
Total	2,937	9,042
Personnel Meters		
Badge Film	1,968	6,918
Pencils	1,805	7,071
Other	211	614
Total	3,984	14,603
Miscellaneous Special Services	867	1,312
Total Number of Calibrations	7,788	24,957

A. R. Keene, Manager
RADIATION PROTECTION

[redacted]

Several memoranda on classification were received from the Hanford Operations Office, and are being readied for distribution to the field. One memorandum contained the revised instructions for the classification of Hanford production data. These instructions reflect a relaxation in the classification policy for production data and should prove more acceptable to HAPO than previous instructions on this matter.

Work Load Statistics

	February	March
Documents routed and discharged	27,283	29,414
Documents issued	12,710	10,367
Documents destroyed	6,175	6,442
Reports abstracted	236	309
Formal R & D reports issued	25	8
Document classification changes	521	469
Books circulated	2,237	2,287
Periodicals circulated	10,707	12,184
Volumes added to the collection	353	313

Manager,
LABORATORY AUXILIARIES

JL Boyd:sf

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
General Plant Projects - FY 1956, AEC-2-23X-56-L-2		Reactor & Fuels	$140,000	$120,000 5-11-56	100 100	2 2	5-23-56 12-7-56	As Completed	9-28-56 8-1-57*
CG-664	350° C Flow Loop - 314 Bldg.	REMARKS: A revised project proposal for additional funds of $20,000 and additional time to complete was submitted to AEC-HOO on 3-24-57. Vendor shipping date for canned motor pump is set for 12-30-57. Requisitions are being processed for placement of orders for instrument panels and controls, immersion heaters, pipe and fittings. *The deionizer installation was completed on 1-31-57.							
General Plant Projects - FY 1957, AEC-2-23-57-N-2		Radiation Protection	$150,000	$150,000 2-4-57	Not Schd. 0	Not Schd. 0	2-18-57 7-30-57	12-31-57	6-1-57 12-31-57
CA-658	Shielded Personnel Monitoring Station (747 Building Addition)	REMARKS: Preliminary cell design and preparation of design criteria progressing. Cell design to incorporate 7¼ inch thick steel plate located at Arco, Idaho. Cell thickness will be approximately 10 inches.							
CG-680	Corrosion Testing Facilities - 314 Bldg.	Reactor & Fuels	$140,000**	$ 29,500* 9-24-56	100 100	Not Schd. Not Schd.	10-3-56 3-20-57*	11-28-58*	1-25-57 1-20-58
		REMARKS: A revised project proposal is being prepared by CEO requesting construction funds incorporating a final project cost estimate. * Interim authorization only for design and procurement. **Total $171,000 includes $31,000 capital equipment transfer.							
CA-685	Alterations to Buildings 325 and 326	HLO	$ 23,000	$ 23,000 10-4-56	100* 100*	Not Schd. Not Schd.	10-1-56 4-9-57	As Completed	11-14-56** 8-15-57
		REMARKS: Installation of the balcony and performance of other work specified in Contract 1172 currently in progress at the 326 Building * G.E. design only **Actual G.E. design date							
CA-700	Geological and Hydrological Wells	Chemical Research	$137,000	$137,000 10-24-56	100 100	Not Schd. 14*	11-8-56 10-24-56	As wells are compld	1-15-57 12-10-57
		REMARKS: U.S.G.S. Wells - Drilling continuing on wells at the BX Tank Farm site in 200-E Area and at Z Facility in 200-W Area. *U.S.G.S. portion only Fixed Price Wells - Contract awarded Hatch Drilling Co. of Half Moon Bay, California for a low bid of $42,790. This figure to be reduced by $2,592 as a result of permitting use of lower cost well casing.							

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

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

GE

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
CA-728	High Level Exposure Facility Addition - 141-H Building	Biology Research	$26,000	$26,000 2-11-57	NS 0	NS 0	3-11-57 9-15-57	12-11-57	7-15-57 1-11-58
		REMARKS: Directive AEC 103 dated 2-11-57. Work Authority CA-728 (1) authorized GE $2,000 to perform preliminary scope, prepare design criteria, review A-E drawings, perform field inspection, evaluate property, perform final acceptance and as builts. Detail design will be performed by L.S. Architect-Engineer. Preparation of design criteria initiated.							
CG-729	Ventilation System Improvements 222-U Building	Chemical Research	$73,000	$73,000 3-12-57	0 0	0 0	4-23-57 1-12-58	6-12-58	6-12-57 9-15-58
		REMARKS: AEC Directive HW-423 dated 3-12-57 authorized the project as described in the project proposal. Design initiated.							
B-5776	Effluent Engineering Test Facility	Chemical Research	$152,000	Pending Pending	0 0	0 0	To be est. To be est.	To be est.	To be est. To be est.
		REMARKS: Project proposal completed and being routed for approval within HLO. Plant and Equipment Analysis Report being routed for approval.							
CG-733	Plutonium Metallurgy Facility Expansion	Research & Fuels	$295,000	$16,000* 3-7-57	0 0	0 0	1 mo.** 1 mo.**	As Compld.	4½ mo.** 13 mo.**
		REMARKS: Interim authorization for preliminary design and minimum renovation and modification of building services and utilities necessary to meet present commitments for products. The scope of decontamination work was defined and an estimate obtained from Construction Operation. *Interim Authorization. **After authorization.							
	Biology Controlled Activity Water System-100-F Area	Biology Research	$19,000	Pending Pending	0 0	0 0	To be est. To be est.	To be est.	To be est. To be est.
		REMARKS: Project proposal being prepared.							

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

DEL

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PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE: DESIGN / CONST.
Equipment Not Included in Construction Projects, FY 1956		Reactor & Fuels	$131,000	$120,000 2-7-57	100 100	0 0	5-1-56 6-1-57	8-31-57	4-1-57 9-30-57
CG-620	Vacuum Furnace	REMARKS: Installation design was completed on schedule of April 1, 1957. Certain vendor drawings have not been received for approval as yet. Some of these are reproducibles and may delay formulation of the bid package.							
Equipment Not Included in Construction Projects, FY 1957		Reactor & Fuels	$147,000	$135,000 3-15-57	100 100	Not Schd. Not Std.	3-27-56 8-1-57	12-31-57	4-1-57 12-31-57
CG-660	Modifications and Additions to Metallographic Cell - 327 Bldg.	REMARKS: Project proposal Revision 2 requesting an extension of the project completion date was approved by the Commission on March 28, 1957. Bid packages for procurement of the cell and cell plugs were transmitted to Purchasing on March 21, 1957.							
CG-661	Additional Heat Generation Facility - 189-D Bldg.	Reactor & Fuels	$700,000	$22,400* 11-13-56	18 21	0 0	12-6-56* Not est.	*	To be est. To be est.
		REMARKS: A revision is being prepared by CEO requesting total project funds. A design schedule was submitted to AEC. Methods of supplying additional heat generation were reviewed in light of recent vendor information and the original selection of static rectifiers was retained. *Interim authorization for preliminary design only.							
CG-672	Monochromatic Neutron Beam Facility - 105-KE Bldg.	Physics & Instr.	$195,000	$195,000 3-7-57	100 100	0 0	5-21-56 7-1-57	6-1-58	10-1-56 5-1-58
		REMARKS: Directive No. HW-384, Mod. 1 dated March 7, 1957 for $195,000 total project funds was received this month. Procurement is continuing with only one bid received on the shielding, segment and slit guide assembly.							
		REMARKS:							

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

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PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
CA-681	Hanford Equipment in the ETR	Reactor & Fuels	$1,200,000	$600,000* / 2-8-57	87.5 / 92	0 / 0	9-17-56 / Not est.	*	5-29-57 / 8-15-58
		REMARKS: Project Proposal Revision No. 2 is being prepared requesting balance of total project funds. Issuance of requisitions for engineered equipment is continuing. A revised work release authority was issued to CEO by HLO this month authorizing CEO to buy all materials. RW Dascenzo and DL Ballard visited the ETR site and made arrangements for Phillips Petroleum Company to receive all materials and made arrangements for Phillips Petroleum Company to receive all materials and equipment. The tentative move-out date for Kaiser Engineers, constructors of the ETR building is now July 1, 1957 instead of June 1, 1957. * G. E. $550,000, AEC $50,000 for partial procurement and complete design.								
CG-682	High Level Cut Off and Examination Cell - 327 Bldg.	Reactor & Fuels	Not Est.	$30,500 / 2-1-57	** / 58	NS / 0	7-18-56 / 6-57	*	6-26-57 / Not Est.
		REMARKS: Design resumed. It is estimated the design cost will exceed the $30,500 but will remain within the allowable overrun. * Directive HW-390 Modification 1 authorized G.E. an increase in design funds for the rescoped cell. Interim authorization for design only. **Schedule being revised.							
CA-695	Radio Telemetering Network	Physics & Instr.	$89,000	$89,000 / 1-10-57	NS / 0	NS / 0	2-21-57 / 7-25-57	4-15-58	4-25-57 / 5-15-58
		REMARKS: Preparation of specifications temporarily delayed because of higher priority work.							
New Construction - FY 1958									
CG-731	Critical Mass Laboratory	Physics & Instr.	$2,000,000	None to date / None to date	Not Sch. / 0	Not Sch. / 0	1 mo.** / *	*	* / *
		REMARKS: The project proposal for $60,000 advance engineering funds for this FY 1959 budget item was returned unapproved from Washington, D.C., AEC. It is tentatively planned to allocate $200,000 out of budget item 58-B-2 for the Critical Mass Laboratory. *To be established. **After authorization.							

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

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-49419 DEL
MARCH 1957

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
None	Metallurgical Development Facility	Reactor & Fuels	$3,600,000	None to date / None to date	0 / 0	0 / 0	* / *	*	* / *

REMARKS:
Project proposal for $100,000 for preliminary design was submitted to the General Manager's office on March 29, 1957 for approval.

* To be established after scoping is performed.

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
B-5848	Plutonium Fabrication Pilot Plant	Reactor & Fuels	*** $4,275,000	None to date / None to date	Not Sch. / Not Sch.	Not Sch. / Not Sch.	** / **	**	** / **

REMARKS: Project proposal for $100,000* is being routed within HLO for approvals.

* For scope design only.
** To be established after scope work.
*** Order of magnitude estimate.

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
	Organic Coolant Test Loop in the ETR	Reactor & Fuels	$750,000	None to date / None to date	0 / 0	0 / 0	* / *	*	* / *

REMARKS:
A project proposal for $100,000 in design funds is being routed for approval within HLO.

* To be established after scoping is performed.

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.

REMARKS:

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
Dr. Donald S. Clark	2-19-57	American Society for Metals and California Institute of Technology, Pasadena, Calif.	Inspection of facilities and presentation of paper	R. B. Socky	None	327 - 300
R. A. Schatzel and R. J. Painter	2-25 & 2-26-57	Rome Cable Co., Rome, N.Y., and American Society for Testing Materials, Philadelphia, Pa.	Inspection of facilities and presentation of program	D. W. McLenegan R. C. Hoffman R. B. Socky	None	327 - 300 761 - 700 760 - 700
R. W. Adams	3-4-57	Triplett & Barton, Inc. Los Angeles, Calif.	Service x-ray equipment	R. B. Socky H. Cruse	None	3708- 300 224-B - 200-E

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. J. Lucas	3-11 - 3-14-57	Third International Atomic Exposition and Fifth Hot Laboratories and Equipment Conference, Philadelphia, Pa.	Attend meetings listed	None	None
R. W. Benoliel	3-11 - 3-15-57 3-18 - 3-20 & 3-22-57 3-21-57	Nuclear Congress Philadelphia, Pa. G.E. Components, New York, Schenectady and Cincinnati Atomic Power Development Association, Detroit, Mich.	Attend Nuclear Congress Talks on professional society activity Talks on possible R & D work by HLO	None C. F. Savage Lowell Steele C. Gray R.E.L.Stanford	None None
P. F. X. Dunigan	3-8 - 3-18-57	Nuclear Congress Hot Laboratory Committee Meeting and Hot Laboratories and Equipment Conference, Philadelphia, Pa.	Attend meetings listed	Frank Ring, Jr. T.J.E.Glasson Ray Goertz Walter J.Laird Lou Stang, Jr. Raymond Westphal	None

At month's end the staff of the Hanford Laboratories Operation totalled 1171, including 477 exempt and 694 non-exempt personnel. Of the total exempt employees there were 415 with college degrees and of that number 398 have technical degrees as follows:

BS	MS	PhD
201	101	96

In addition there were 37 non-exempt employees with degrees.

Distribution among the nine level 3 components is included in Table I.

Personnel Development and Communications

The exempt skills' inventory was completed on the keysort system during the month. Plans include replacing this with an expanded inventory during the coming year.

The human relations course "Understanding People" was presented to an HLO pilot group and was received very favorably.

At month's end 26 Technical Graduates and 18 Technician Trainees were assigned within the Hanford Laboratories Operation as compared with 27 and 22 respectively in February.

General assistance was rendered in the preparation of script and providing displays for the Manager's appearance on the television broadcast on March 6.

Twenty-four technical papers, speeches and signed articles and nine press releases were processed during the month.

Personnel Practices

Suggestions - At the March meeting of the Suggestion Board, 12 suggestions were reviewed and 6 were adopted. Three of the suggestions represented savings totalling $323.00 and 3 represented intangible savings. A total of $80.00 was granted in awards.

During March, 21 suggestions representing 3 suggestions per 100 eligible employees were received from Laboratories personnel.

Selective Service - Hanford Laboratories Operation currently has 206 employees subject to Military Service of which 78 are Reservists or National Guard members and 128 are non-veterans. Of the 78 employees in National Guard or Reservist categories, 43 are technical employees, 3 of whom are classified as I-A and deferments are being requested. Of the 128 non-veterans, 76 are technically trained or engineering personnel, and deferments have been granted or are being processed for 41. Of the 52 non-technical non-veterans 22 are classified as I-A.

Personnel Practices (continued)

Benefits - Hanford Laboratories' participation in the Employee Benefit plans as of the end of March is listed below:

	March	February
Pension Plan	97.7	97.6
Insurance Plan	99.4	99.4
Savings & Stock Bonus Plan	58.6	58.7
Savings Plan	8.8	8.1

Placement & Records - At the end of the month there were 40 openings in HLO. However, only 4 of these represent ones open for immediate placement.

During the month Hanford Laboratories transferred 4 employees to other HAPO components and 2 were transferred into HLO from other components. Six transfer requests were received, all of which involved personal reasons.

Ten attendance recognition awards were issued during the month including four one-year, three two-year, two five-year and one six-year awards. There were four five-year and five ten-year service recognition pins issued during the month.

Technical Personnel Placement

PhD Recruiting

Fourteen candidates visited Richland for Hanford Laboratories Operation interviews. Six offers were extended, 1 offer accepted, 3 offers rejected and 1 PhD candidate was placed on the roll.

Experienced BS/MS Recruiting

Eight experienced candidates visited Richland with 2 offers being extended and 1 candidate signed on the roll. The statistical picture of technical recruiting is included in Table III.

Transfers

Four new transfer cases were received during the month. This may be compared with 5 during February. The status of exempt transfers is summarized in Table IV.

Summer Professors Program

Seven professors will be joining the Laboratories Operation on the 1957 Summer Professors Program.

Union Relations

Negotiations are continuing with the Regional Monitors in an attempt to resolve the various factors surrounding their agreement.

Union Relations (continued)

Conferences are continuing on the Wonacott arbitration case regarding jurisdiction of Radiation Monitors. The outlook for settlement of this case is not favorable.

No grievances were received during the month. Seventeen grievances have been processed since September 1 and the status of these is outlined in Table V.

Salary and Wage Administration

At month's end 85 per cent of the performance appraisals for 1956 were on file in this office.

The auditing of position guides is proceeding satisfactorily and will remain on schedule.

Preliminary plans for a salary reconciliation trip have been made for the month of June.

All secretaries in HLO have now been placed on the new secretarial plan.

Health and Safety

In March, Laboratories personnel worked a total of 190,947 hours with no disabling injuries. There were 38 medical treatment injuries with a frequency of 1.98 as compared to 1.73 for the previous month. The frequency for the year to date is 1.74.

There were two runs by the fire department to Laboratories buildings, one in response to smoke in 329 building from an overheated transformer in a light fixture, the other to a small hood fire in 325 building when a Bunsen burner backfired and ignited loose papers.

Eight security violation incidents were processed making the 1957 total 29 to date.

Special scheduling of medical examinations was arranged for personnel of Radiological Development Operation to assist in evaluating the possibility of hazards during X-ray exposure.

Through March 25, 90% of the medical examinations scheduled for HLO personnel this year were completed.

The revision of a Civil Defense and Plant Evacuation procedure was prepared in conjunction with Fuels Preparation Department with the objective of providing a uniform procedure for 300 Area and proper distribution of responsibilities.

Manager
Employee Relations

T.G. Marshall:vf

TABLE III. EMPLOYMENT - TECHNICAL PERSONNEL STATUS

I. Employment

Non-Exempt Employment Status	Feb.	March
Requisitions		
At end of month	39	40
Cancelled	1	0
Received during month	10	10
Filled during month	19	9
Candidates Considered		
Total Applications	16	11
Total Transfer Request from other at HAPO	7	7
Total Interviewed	5	0

Non-Exempt Transfer Requests	Feb.	March
Transfer Cases		
Active cases at end of month	43	43
Cancelled	1	3
New during month	6	6
Transfers effected	3	3
Planned Transfers		
Effective during month	2	0

II. Technical Personnel Placement

Ph.D. Recruiting

	Cases Considered	VISITS TO RICHLAND: Extended	Visited	To Visit	Open Invite.	OFFERS: Extended*	Accepted*	Open*	On The Roll
Engineering:									
Chemical	57	28	7	9	6	3	1	1	-
Electrical	17	7	-	6	1	1	-	1	-
Mechanical	19**	11	2	2	6	3	1	1	-
Metallurgical	37	22	4	4	11	4	-	1	-
Civil	2	-	-	-	-	-	-	-	-
Science:									
Chemistry	195	78	16	27	12	9	1	3	1
Physics	212**	101	16	29	35	13***	2	6***	2
Math-Stat.	40**	12	1	2	6	-	-	-	-
Other	33**	8	5	2	-	4	3	-	1
DVM	3	-**	-**	-	-	1	1	-	1
TOTAL	615	267	51	81	77	38	9	13	5

*Offer totals include 12 carry-overs from the 1955-56 season with 3 acceptances not on the roll as of 9/1/56 and 7 open offers at that time. (2 acceptances now rejected)
**1 Case transferred from Phys. to Math-Stat. and 3 Cases transferred from Other to ME to correct error. 1 DVM shown as visited in error, was offer open as of 9/1/56.
*** 1 Carry-over open offer from 1955-56 now withdrawn.

BS/MS Experienced Recruiting

	Cases Considered	VISITS TO RICHLAND: Extended	Visited	To Visit	Open Invite.	OFFERS: Extended*	Accepted*	Open*	On The Roll
Engineering:									
Chemical	14	7	4	-	-	-	-	-	-
Electrical	17	12	6	-	1	2	1	1	1
Mechanical	19	14	9	1	-	4	1	2	1
Industrial	4	3	2	-	-	2	1	1	1
Metallurgical	13	9	3	2	1	2	2	-	1
Ceramic	3**	3**	2**	1	-	3	1	2	1
Other	11	4	1	-	1	-	-	-	-
Science:									
Chemistry	18	5	1	-	-	-**	-	-	-
Physics	9	5	3	1	-	2	1	-	1
Math-Stat.	3**	2**	2**	-	-	3	2	1	2
Other	23	-2	2	-	-	-	-	-	-
TOTALS	134	66	35	5	3	18	9	7	8

*Includes 2 carry-overs from 1955-56 season. ** Corrected figures.

IV. Exempt Transfer Cases

		Mar.	Feb.
Active cases at end of month		19	20
Total cases since 9/1/56		59	55
(Includes those initiated prior to 9/1/56)			
Initiated by employee	43		39
Initiated by management*	16		16
New cases during month		4	5
Initiated by employee	4		4
Initiated by management*	0		1
Cases re-activated during month	0		2
Cases closed during month		5	6
Transfers effected: Within HLO	1		1
Within HAPO	1		0
Other G.E.	0		3
Requests withdrawn	2		2
Terminated	1		0

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

V. Union Relations

Grievances Processed - September 1, 1956 to date.

Total processed: 17 (includes 1 non-unit grievance)

Step I

Pending Step I Answer	0
Answered Satisfactorily*	7
Pending time limit	1

Step II

Pending Step II Discussion	0
Pending Step II Answer	1
Answered	
Satisfactorily**	6
Unsatisfactorily	0
Pending time limit	2

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

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

FINANCIAL OPERATION MONTHLY REPORT
March, 1957

Compiled by Members of the
FINANCIAL OPERATION
HANFORD LABORATORIES OPERATION

Personnel

Doris L. Greenfield, a cost clerk in Cost Accounting Operation, died March 10, 1957.

Activities

General Accounting Operation

A new posting machine for posting to the general ledger, travel aivance sub-ledger, and property records, was received during the month. Also, a printing calculator was received in exchange for a calculator and an adding machine.

Arrangements were made to type checks for travel advances and for certain payroll purposes, effective April 1. Signing of checks and control of bank accounts will continue to be the responsibility of Relations and Utilities Operation.

The budget for Equipment Not Included in Construction Projects, for FY 1959 and Revision of FY 1958, was submitted to Contract Administration on March 8, the due date.

A physical inventory of uninstalled catalogued equipment in the custody of Radiation Protection Operation began March 4. The physical count is complete; completion of the reconciliation with and correction of book records is scheduled for May 15, 1957.

A physical inventory of shop stock material in the custody of Technical Shops Operation begain March 29. The inventory and correction of book records will be completed in April.

Two new materials, heavy water and gallium, were established in inventory accounts as of March 31, 1957. Operating costs were credited with $13,348 as a result of these transfers to inventory accounts.

Cost Accounting Operation

Work continued on the preparation of the Budget for FY 1959 and Revision of Budget for FY 1958, due in April.

Personnel Accounting Operation

1951 participants in the Savings and Stock Bonus Plan received their bonds, common stock and accumulated income during March.

Reports showing absentee statistics were revised to show data directly related to measurement indices.

Arrangements were made to review travel expense accounts of area employees to determine that days in travel status are not reported as days worked in the area.

Auditing

The Specialist - Auditing continued to assist the traveling auditors on a loaned basis.

Office Procedures

A systems study of property accounting procedures in the General Accounting Operation was begun.

Payroll Statistics

Changes during month	Total	Exempt	Non-Exempt
Employees on payroll at beginning of month	1 176	475	701
Additions and transfers in	13	3	10
Removals and transfers out	(18)	(2)	(16)
Transfers from weekly to monthly payroll	-0-	1	(1)
Employees on payroll at end of month	1 171	477	694

Gross payroll paid	March	February
Exempt	$345 928	$341 513
Non-exempt (5 weeks in March)	340 260	274 496
	$686 188	$616 009

Overtime payments		
Exempt	$ 3 241	$ 4 282
Non-exempt (5 weeks in March)	10 350	10 557
	$13 591	$14 839

Insurance claims paid

	March		February	
	Number	Amount	Number	Amount
Employee				
Life insurance	1	$11 297	-0-	$ -0-
Weekly sickness and accident	14	1 623	15	1 255
Comprehensive medical	45	4 446	65	5 115
Dependents				
Comprehensive medical	55	3 409	154	9 928
	115	$20 775	234	$16 298

Good Neighbor Fund	March	February
Number participating	801	807
Percent participating	68.4%	68.6%

Other Statistics

Cash advances and travel expenses

		March		February
Advances outstanding at beginning		$ 9 872		$11 538
Advances issued - by checks	61	10 593	38	6 298
- by cash	36	5 305	18	2 190
- air travel orders		9 629		2 793
		35 399		22 819
Less:				
Expense vouchers processed				
Travel expense accounts	54	12 999	33	8 394
Other (movement of household goods, conference expense, etc.)	32	671	25	570
Refunds of advances	46	5 404	29	3 380
Billing to and from HAPO components - net		941		603
		20 015		12 947
Advances outstanding at close	40	$15 384	31	$ 9 872
Ages of advances outstanding				
15 days or less	32	$11 870	29	$ 9 352
16 - 30 days	8	3 514	2	520
		$15 384		$ 9 872

Project proposals and appropriation requests

	Project proposals	Appropriation requests
On hand beginning of month	-	-
Received	3	10
	3	10
Recommended for approval	3	6
Returned for rewrite	-	3
Cancelled	-	1
	3	10
On hand at close of month	-	-
Appropriation requests receiving final approval during month		
Number		5
Amount		$21 210

J. P. Holmes

JP Holmes:bb
3-11-57